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NATIONAL DAM INSPECTION PROGRAM. EBENSBURG STORAGE DAM (NDI ID --ETC(U)
1980 L D ANDERSEN DACW31-80-C-0022

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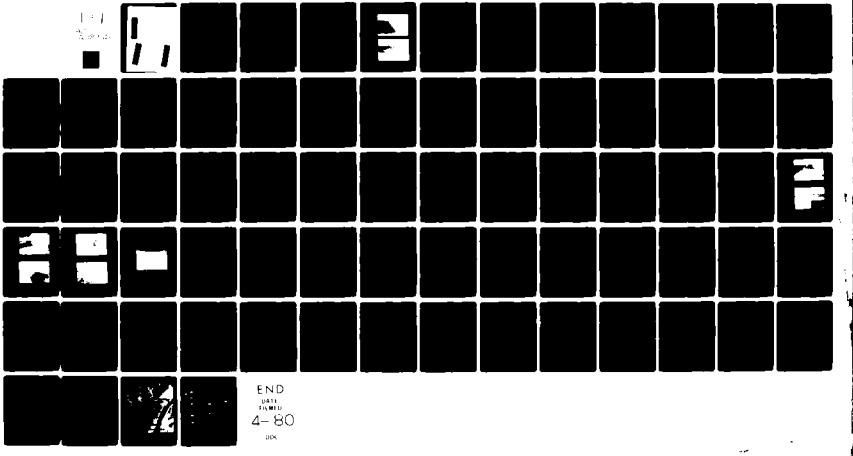

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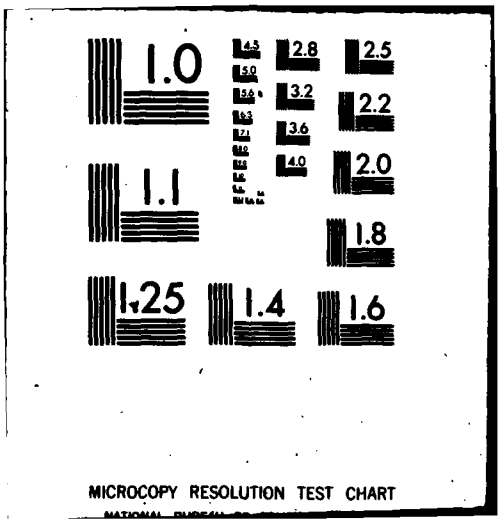
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MICROCOPY RESOLUTION TEST CHART

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

(12) 72 (19) Lawrence D. Andersen

(11) 1980

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM.

NAME OF DAM: Ebensburg Storage Dam (NDI ID Number PA-00442, DER ID Number 11-61), Ohio River Basin (Mormons Woods Run) Howells Run, Cambria County, Pennsylvania. Phase I Inspection Report.
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Cambria
STREAM: Howell's Run
SIZE CLASSIFICATION: Small
HAZARD CLASSIFICATION: High
OWNER: Borough of Ebensburg
DATE OF INSPECTION: November 14 and December 12, 1979

ASSESSMENT: Based on the evaluation of the conditions, Ebensburg Storage Dam is considered to be unsafe/nonemergency due to the presence of slumps and wet areas on the downstream slope of the dam. Detailed investigation of the dam to control the seepage and slumping on the downstream face of the dam is recommended.

It is reported that the outlet pipe gate has not been operated in the recent past. It is therefore recommended that the owner evaluate the operational condition of the pipe gate and perform the necessary maintenance.

(15) DACW31-80-C-0002

The flood discharge capacity of the Ebensburg Storage Dam was evaluated according to the recommended procedure and was found to pass 20 percent of the probable maximum flood (PMF) without overtopping the low spot on the crest of the dam. Therefore, according to the recommended criteria, the flood discharge capacity of the dam is classified to be inadequate. However, it was found that during the passage of 20 percent of the PMF, backwater from a railroad embankment located approximately 1000 feet downstream from the dam would increase the tailwater at the dam site to within 6 feet of the spillway crest, significantly reducing the breaching potential due to overtopping of the dam. Therefore, the spillway capacity is not considered to be seriously inadequate. However, if the downstream railroad embankment were to be removed in the future, the adequacy of the spillway or need for increasing spillway capacity should be reevaluated. It was estimated that the filling of the low spots on the crest of the embankment would increase the spillway capacity to about 40 percent of the PMF.

The following recommendations should be implemented immediately or on a continuing basis:

1. The owner should immediately retain a professional engineer for detailed evaluation of the dam and prepare and execute plans for: (a) controlling seepage and

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slumping on the downstream face of the dam and (b) evaluating the integrity of the embankment in view of the observed conditions. The detailed evaluation of the dam should include, but not be limited to, subsurface investigations, materials testing, and seepage and stability analyses.

2. In conjunction with the detailed evaluation of the dam, the crest of the dam should be surveyed and the low spot filled to the design elevation.

3. The operational condition of the sluice gate should be evaluated and necessary maintenance performed.

4. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

5. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed. A review of the regional geology indicates that some deep coal mine workings exist in the vicinity of the dam site. Therefore, future inspections should include a search for any indications of subsidence.

Lawrence D. Andersen, P.E.
Vice President

January 28, 1980
Date

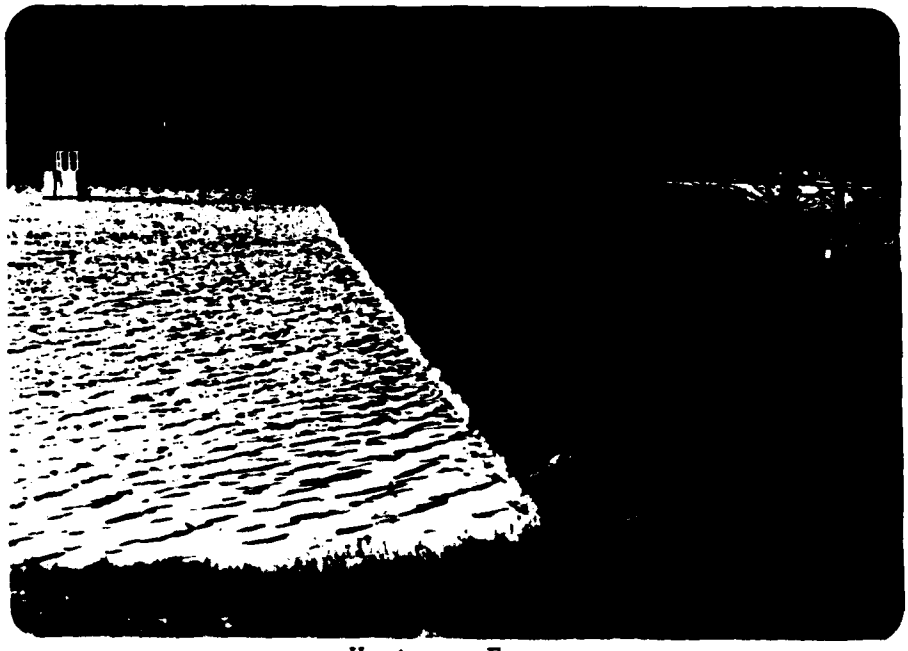
Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date 25 Feb 1980

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
Lawrence D. Andersen
ENGINEER
No. 17458-E

EBENSBURG STORAGE DAM
NDI I.D. PA-422
NOVEMBER 14, 1979



Upstream Face

Downstream Face

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
EBENSBURG STORAGE DAM
NDI I.D. PA 442
DER I.D. 11-61

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. Ebensburg Storage Dam consists of an earth embankment approximately 450 feet long with a maximum height of 16 feet from the downstream toe and a crest width in the range of 12 to 14 feet. On the downstream slope, a rock toe is located in the middle one-third of the embankment, extending to approximately midheight of the dam. On the upstream slope, cast-in-place concrete slabs extending approximately 4 feet above normal pool level constitute the upstream slope protection. The flood discharge facilities for the dam consist of a 56-foot-wide, 3-foot-deep channel on the left abutment. The spillway channel discharges into a plunge pool at the toe level near the left abutment. The outlet works include a reinforced concrete intake tower and 20-inch blow-off pipe and 12-inch supply pipe. Both of these pipes are encased in concrete through the embankment. Flow through these pipes is controlled by valves on the upstream intake tower. This outlet system constitutes the emergency drawdown facilities for the reservoir.

b. Location. The Ebensburg Storage Dam is located northeast of Ebensburg in Cambria Township, Cambria County, Pennsylvania (Plate 1).

c. Size Classification. Small (based on 16-foot height and 131 acre-feet maximum storage capacity).

d. Hazard Classification. The dam is classified to be in the high hazard category. The city of Ebensburg's water treament plant is located immediately downstream from the dam. Approximately 1000 feet downstream from the dam, Howell's Run flows under a 20-foot-high railroad embankment. It is estimated that in the event of a dam failure, the railroad embankment can impound the discharge from the dam without overtopping. However, since the structural adequacy of this embankment as a water retention structure is questionable and subsequent failure of this embankment would cause loss of life and property damage further downstream, the Ebensburg Storage Dam is classified to be in the high hazard category.

e. Ownership. Borough of Ebensburg, (address: Mr. William Bumford, Borough Manager, Ebensburg Borough, 300 West High Street, Ebensburg, Pennsylvania 15931).

f. Purpose of Dam. Water supply.

g. Design and Construction History. The dam was designed by borough engineers and constructed by Leard Elder & Son, a construction company from Ebensburg, Pennsylvania, with completion in 1923.

h. Normal Operating Procedure. The reservoir is normally maintained at Elevation 1990, the level of uncontrolled spillway crest level. When the lake is at or above the spillway level, inflow is discharged through the uncontrolled spillway.

1.3 Pertinent Data. Elevations referred to in this and subsequent sections of the report were calculated based on approximate field measurements assuming the spillway crest elevation to be 1990 (USGS Datum), which is interpolated from the USGS 7.5 minute Ebensburg quadrangle map.

a. Drainage Area	1.9 square miles
b. Discharge at Dam Site (cfs)	
Maximum known flood at dam site	350 cfs (in 1936)
Outlet conduit at maximum pool	Unknown
Gated spillway capacity at maximum pool	Not applicable
Ungated spillway capacity at maximum pool	528
Total spillway capacity at maximum pool	528(1)

(1) See Appendix D, Page D4 of 11, routing through Ebensburg Storage Dam line outflow.

c. Elevation (USGS Datum) (feet)

Top of dam	1992.1 (measured low spot)
Maximum pool	1992.1
Normal pool	1990
Upstream invert outlet works	1968±
Downstream invert outlet works	Unknown
Streambed at center line of dam	1965±
Maximum tailwater	Unknown
Downstream toe	1976

d. Reservoir Length (feet)

Normal pool level	1600
Maximum pool level	1600 (estimated)

e. Storage (acre-feet)

Normal pool level	92
Maximum pool level	131

f. Reservoir Surface (acres)

Normal pool level	9.2
Maximum pool level	13±

g. Dam

Type	Earth
Length	450 feet
Height	16 feet
Top width	12 to 14 feet
Side slopes	Downstream: 2 Horizontal: 1 Vertical Upstream: 2 Horizontal: 1 Vertical
Zoning	Yes
Impervious core	Yes
Cutoff	Yes
Grout curtain	None

h. Regulating Outlet.

Type	20-inch cast iron pipe

Length	150 feet±
Closure	Upstream valves
Access	Foot bridge
Regulating facilities	Valves at intake tower

i. Spillway

Type	Broad-crested overflow section
Length	56 feet
Crest elevation	1990
Gates	None
Upstream channel	Lake
Downstream channel	Rectangular concrete discharge channel

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available data, consisting of files and design drawings, were provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER).

(1) Hydrology and Hydraulics. No hyrology and hydraulic analyses are available. The records include design capacity of the spillway.

(2) Embankment. Available information includes design drawings and a report prepared by the state upon the review of the original design.

(3) Appurtenant Structures. Design drawings are not available for the appurtenant structures.

b. Design Features

(1) Embankment. The dam consists of an earth embankment impounding a 9-acre reservoir. Plates 2 and 3 illustrate the plan of the reservoir and the dam, respectively. A typical cross section of the embankment is illustrated in Plate 4. It consists of two zones. The zones are identified to be "selected material rolled" on the upstream side and "material rolled" on the downstream side. The upstream side of the dam is protected by a 10-inch concrete slab extending approximately one foot above the normal pool level to a concrete cutoff wall located at the upstream toe of the dam. The design drawings show the upstream cutoff wall to be two feet thick, extending for the entire length of the dam. Construction progress reports indicate that the cutoff wall was extended to the impervious layers. The design drawings also indicate that a three-foot-wide puddle clay fill was placed on the downstream side of this concrete cutoff wall. A state report, dated 1922, indicates that no subsurface investigation was conducted prior to the construction of the dam.

(2) Appurtenant Structures. The appurtenant structures for the dam consist of an overflow spillway and outlet works. The spillway structures include a rectangular concrete channel located on the left abutment, discharging into a stilling basin near the toe level. As it presently exists, the spillway channel at the control section is 56 feet wide and 3.1 feet

deep. Plate 5 illustrates the designed spillway cross section and profile. The outlet works facilities for the dam consist of a reinforced concrete intake tower and a 20-inch blow-off pipe and 12-inch supply pipe located at the center of the embankment. The design drawings and construction progress reports indicate that the outlet pipes were encased in concrete through the embankment. No information was available on the details of the intake tower. Original drawings do not show such an intake structure. However, to the knowledge of the owner, the intake tower was constructed in conjunction with the construction of the dam. Flow through the outlet pipes is controlled by valves located in the intake tower.

c. Design Data.

(1) Hydrology and Hydraulics. The state report entitled, Report Upon the Application of the Borough of Ebensburg, dated May 19, 1922, reported the full capacity of the spillway to be 1140 cfs, based on a 55-foot width and 4-foot depth.

(2) Embankment. The available information includes no quantitative design data for the embankment.

2.2 Construction. Very limited information is available on the construction of the dam. The only reported construction difficulty was encountered during the excavation of the cutoff trench. At the bottom of the valley, adequately impervious strata were encountered at depths of 6 to 12 feet. On the sides of the valley, cutoff trenches were extended to depths up to 23 feet without encountering adequate impervious layers.

2.3 Operation. No formal operating records are available for the dam. According to correspondence included in the state files, the highest pool level occurred during the 1936 flood, when the flow depth in the spillway was reported to be 19 inches, which was estimated to correspond to a discharge of 350 cfs.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. The available information was provided by PennDER.

b. Adequacy. The available information includes no technical data to assess the design of the embankment. Therefore, the available information is not considered sufficient to evaluate the adequacy of the design and the construction of the dam.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Ebensburg Storage Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.

2. Visual examination of the appurtenant structures.

3. Evaluation of the downstream area hazard potential.

The specific observations are illustrated in Plate 6.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

The two most significant conditions noted at the dam site were the presence of wet areas in a the middle half of the downstream slope starting at a level about 8 feet from the crest level and extending to the toe of the embankment. Two slumps associated with this seepage through the embankment are located on each side of the rock-fill along the toe of the dam. The slump located on the right side of the rock toe appears to cover an area approximately 30 feet long and has settled by about three to four feet relative to the original downstream slope. A swampy area is located below the toe of the dam in line with this slump. The discharge from the seepage area is estimated to be on the order of 5 to 10 gallons per minute. No measurable seepage appears to be associated with the wet areas on the remaining portion of the downstream slope.

The crest of the dam was surveyed relative to the spillway crest level. The freeboard was found to range from 2.5 feet adjacent to the spillway wall to about 4.7 feet near the right abutment. A 200-foot section of the crest measured from the spillway side was found to be below the top of the spillway wall elevation, which was presumed to be the design elevation for the embankment crest. The dam crest profile is illustrated in Plate 7.

c. Appurtenant Structures. The spillway structures were examined for deterioration or other signs of distress or obstructions

that would limit the flow. The spillway structures were found to be in good condition.

d. Reservoir Area. Approximately 80 percent of the watershed of the Ebensburg Storage Dam initially drains into Howell's Run Dam, which is located about 1/2 mile upstream. While the watershed is predominantly covered with farmlands, the Ebensburg Storage Dam also receives runoff from urban residential areas located at the southern end of the watershed area. A review of the regional geology (Appendix F) indicates that the shoreline of the reservoir is not likely to be susceptible to massive landslides which would affect the storage volume of the reservoir. This review also indicated that deep coal mine workings exist in the vicinity of the dam site, posing potential for subsidence. In this inspection, no signs of subsidence were observed.

e. Downstream Channel. Approximately 1000 feet downstream from the dam, Howell's Run flows under a 20-foot-high railroad embankment and discharges into a small lake locally known as Lake Jenks. One residence and several park buildings are located in the vicinity of Lake Jenks. Discharge from Lake Jenks flows under a second railroad embankment through two 9-foot-diameter culverts, following which the stream flows through a developed area southeast of Ebensburg.

3.2 Evaluation. In view of the presence of seepage and slumps on the downstream face of the dam, the condition of the dam is considered to be poor. The observed conditions raise concern as to the continued stability of the embankment. Therefore, a detailed investigation of the embankment is recommended.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The reservoir is normally maintained at the crest level of the uncontrolled spillway, with excess inflow discharging through the spillway.

4.2 Maintenance of the Dam. The maintenance condition of the dam is considered to be fair. The crest and downstream face of the dam are covered with grass. While the crest of the dam appears to be periodically mowed, some brush was found on the downstream slope near the right abutment.

4.3 Maintenance of Operating Facilities. The operation of the outlet pipes sluice gate was unobserved. Borough personnel reported that the gate has not been operated in the last several years. However, the downstream end of the outlet pipe could not be located. Apparently, during the construction of the water treatment plant, which is located immediately downstream from the dam, the blow-off pipe was rerouted to a point further downstream, which could not be identified.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available from the water treatment plant at the dam site.

4.5 Evaluation. The maintenance condition of the dam and the operating facilities are considered to be fair. It is recommended that the owner locate the downstream end of the blow-off pipe and evaluate the operational condition of the blow-off pipe sluice gate.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Ebensburg Storage Dam has a watershed of 1.9 square miles and impounds a reservoir with a surface area of 9.2 acres at normal pool level. The flood discharge facilities for the dam consist of an overflow spillway located on the left abutment. The flood discharge capacity of the spillway, based on the available head relative to a low spot on the crest of the dam, was estimated to be 528 cfs. Howell's Run Dam, with a watershed of 1.4 square miles, which impounds a reservoir of 84 acres, is located approximately 1/2 mile upstream from this dam.

b. Experience Data. As previously stated, Ebensburg Storage Dam is classified as a small dam in the high hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass half to full PMF.

The PMF inflow hydrograph for the reservoir was determined utilizing the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers.

The hydrographs for the Ebensburg Storage Dam were determined by initially routing the hydrograph through the upstream dam and combining the outflow with the discharge contributed from the watershed downstream from Howell's Run Dam. The data used for the computer analysis are presented in Appendix D. The full and one-half PMF inflow hydrographs were found to have peaks of 3290 and 1490 cfs, respectively. The computer outputs are included in Appendix D.

c. Visual Observations. On the date of inspection, no conditions were observed that would indicate that the spillway of the dam would not operate satisfactorily in the event of a flood.

d. Overtopping Potential. Various percentages of the PMF inflow hydrograph were routed through the reservoir starting from normal pool elevation. It was found that the dam can pass 20 percent of the PMF without overtopping the embankment. At 50 percent of PMF, the low spot on the embankment would be overtopped for a duration of 9-1/2 hours, with a maximum depth of 1.05 feet. Further routing of the flood through the downstream railroad embankment culvert (a 5-foot-diameter pipe) indicates that during the passage of 20 percent PMF, backwater from the railroad embankment

would increase the tailwater at the dam site to a level within six feet of the spillway crest. The computer input for this analysis and the pertinent sections of the computer output are included in Appendix D. The railroad embankment culvert and hydraulic characteristics are illustrated in a sketch included in Appendix D.

A flood routing conducted assuming the low spots on the crest of the dam were filled to the level of the spillway wall indicates that the dam would pass 40 percent of the PMF without overtopping.

e. Spillway Adequacy. The spillway capacity is found to be less than the recommended spillway design flood range of half to full PMF. Therefore, according to the recommended criteria, the spillway capacity is classified to be inadequate. However, it is not considered to be seriously inadequate, because during the passage of 20 percent or larger percentages of the PMF, backwater from the downstream railroad embankment would increase the tailwater at the dam site to within six feet of the spillway crest or higher; therefore, reducing the breach potential for the dam.

A review of the flood routing data through the downstream railroad embankment indicates that the railroad embankment during the passage of large storms would overtop while impounding a temporary reservoir approximately equal to Ebensburg Storage Dam in storage capacity. Because backwater from the railroad embankment will significantly increase the tailwater at the Ebensburg Storage Dam, reducing its breach potential, failure of the Ebensburg Storage Dam is likely to occur following the failure of the downstream railroad embankment.

The above description of the probable sequence of events during the passage of a severe storm indicates that initial downstream damage would be caused by the failure of the railroad embankment, and it is estimated that subsequent failure of the Ebensburg Storage Dam would not introduce significant added damage.

It should be noted that if the railroad embankment were to be removed, or the size of the culvert through the embankment were to be increased, eliminating the high tailwater at the dam site during the passage of severe storms, which in turn increases the breach potenital of the dam, the need for increasing the spillway capacity should be reinvestigated.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, the field observations revealed various signs of distress consisting of extensive wet areas and slumps on the downstream face of the dam. Because the design lacks a positive internal drainage system, concern exists as to the effect of seepage on the stability of the embankment. Although previous inspections indicate that the seepage conditions have existed since the initial filling of the dam, no slumping conditions have been reported. Presently observed slumps on the downstream face indicate that the condition of the embankment is degrading. Therefore, the integrity of the embankment as an impoundment structure should be investigated and reevaluated.

(2) Appurtenant Structures. A review of the available information and visual observations indicate that there are no apparent structural deficiencies that would significantly affect the performance of the appurtenant structures.

b. Design and Construction Data. No quantitative design and construction data are available on the design of the dam.

c. Operating Records. No operating records are kept for the dam.

d. Post-Construction Changes. There are no formal records of post-construction changes. However, field observations suggest that two post-construction changes were undertaken. It appears that the area below the toe of the dam was raised approximately 8 feet, in conjunction with the construction of the water treatment plant immediately downstream from the dam. The design drawings indicate the height of the dam to be 24 feet. During this inspection, the height of the dam was measured to be 16 feet. The rock-fill on the middle one-third of the downstream slope extending from toe level to a level about 8 feet below the crest level also appears to have been constructed after the original construction.

e. Seismic Stability. In view of the concerns that exist as to the static stability of the dam, the seismic stability of the dam is also considered to be questionable. Therefore, the seismic stability of the dam should be reassessed in conjunction with further investigation and evaluation of the embankment.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS
PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. Visual observations indicate that the Ebensburg Storage Dam is in poor condition. In view of the presence of wet areas and slumps on the downstream face of the dam, the condition of the dam is assessed to be unsafe/nonemergency. Although available records indicate that the wet conditions on the downstream slope of the dam have existed since shortly after initial filling of the reservoir and in the past some attempts were made to control this wetness by placing rock-fill on the downstream slope, the presence of slumps suggests that the condition is degrading. Therefore, detailed investigation of the condition of the dam and implementation of necessary remedial measures are recommended.

It is also recommended that the owner locate the downstream end of the outlet pipe and evaluate the operational condition of the outlet pipe sluice gate.

The capacity of the spillway was found to be approximately 20 percent of the PMF, which is less than the recommended capacity based on the size and hazard classification for the dam. Therefore, the spillway is classified to be inadequate according to the recommended criteria. However, as discussed in Section 5, the spillway capacity is not considered to be seriously inadequate. A further analysis indicates that if the low spots on the crest of the dam were to be filled to the level of the spillway channel walls, the capacity of the spillway would be approximately 40 percent of the PMF.

However, if the downstream railroad embankment were to be removed in the future, the adequacy of the spillway or need for increasing the spillway capacity should be reevaluated.

b. Adequacy of Information. Available information in conjunction with visual observations is considered to be sufficient to make the following recommendations.

c. Urgency. The following recommendations should be implemented immediately or on a continuing basis.

d. Necessity for Additional Data. It is recommended that the dam be investigated and evaluated by a professional engineer experienced in the design and construction of dams to more

accurately ascertain the consequences of the observed conditions and the overall integrity of the dam and to develop plans for remedial measures.

7.2 Recommendations and Remedial Measures

1. The owner should immediately retain a professional engineer for detailed evaluation of the dam and prepare and execute plans for: (a) controlling seepage and slumping on the downstream face of the dam and (b) evaluating the integrity of the embankment in view of the observed conditions. The detailed evaluation of the dam should include, but not be limited to, subsurface investigations, materials testing, and seepage and stability analyses.

2. In conjunction with the detailed evaluation of the dam, the crest of the dam should be surveyed and the low spot filled to the design elevation.

3. The operational condition of the sluice gate should be evaluated and necessary maintentance performed.

4. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

5. The dam and appurtentant structures should be inspected regularly and necessary maintenance performed. A review of the regional geology indicates that some deep coal mine workings exist in the vicinity of the dam site. Therefore, future inspections should include a search for indications of subsidence.

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Ebensburg Storage Dam COUNTY Cambria STATE Pennsylvania ID# NDI PA 442
DER 11-61

TYPE OF DAM Earth HAZARD CATEGORY High

DATE(S) INSPECTION November 14, 1979 WEATHER Cloudy TEMPERATURE 30s

POOL ELEVATION AT TIME OF INSPECTION 1990 M.S.L. TAILWATER AT TIME OF INSPECTION 1895± M.S.L.

INSPECTION PERSONNEL:	REVIEW INSPECTION PERSONNEL: (December 12, 1979)
Bilgin Erel	L. D. Andersen
Wah-Tak Chan	J. H. Poellot
	B. Erel

Bilgin Erel RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	A minor slump on the left side of the rock toe and a major slump on the right side of the rock toe (see Plate 6)	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	See Plate 7 for dam crest profile.	The low spots on the crest should be filled to the design elevation.
RIPRAP FAILURES	None (upstream slope of the dam is protected by concrete slabs)	

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No signs of distress.	
ANY NOTICEABLE SEEPAGE	See Plate 6 for location of wet areas and seepage points.	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Cracking or spalling of the downstream end of the outlet conduit could not be located.	
INTAKE STRUCTURE	Good condition.	
OUTLET STRUCTURE	Could not be located.	
OUTLET CHANNEL	Could not be located.	
EMERGENCY GATE	The operation of the emergency gate was not observed.	The operational condition of the emergency gate should be observed.

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Broad-crested concrete weir in good condition.	
APPROACH CHANNEL	Good condition.	
DISCHARGE CHANNEL	Reinforced concrete channel in good condition.	
BRIDGE AND PIERS	None	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable	
APPROACH CHANNEL	Not applicable	
DISCHARGE CHANNEL	Not applicable	
BRIDGE PIERS	Not applicable	
GATES AND OPERATION EQUIPMENT	Not applicable	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Not applicable	
OBSERVATION WELLS	Not applicable	
WEIRS	Not applicable	
PIEZOMETERS	Not applicable	
OTHER	Not applicable	

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Gentle to moderately steep. No significant shoreline erosion.	
SEDIMENTATION	Unknown	
UPSTREAM RESERVOIRS	Howell's Run Dam (NDI I.D. PA 434) is located approximately 1/2 mile upstream of this dam.	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Approximately 1000 feet downstream from the dam, Howell's Run flows through a five-foot culvert under a 20-foot-high railroad embankment. During major storms, backwater flooding from this railroad embankment culvert is considered to be likely.	
SLOPES	No apparent instability.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Ebensburg water treatment plant is located immediately downstream from the dam. Approximately 15 homes and several commercial buildings are located approximately 1/2 mile downstream from the dam.	

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC AND HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Ebensburg Storage Dam
ID# PA 442
DER 11-61

ITEM	REMARKS
AS-BUILT DRAWINGS	A limited number of drawings are available in the state files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was constructed by Leard Elder & Son, Engineers and Contractors of Ebensburg, Pennsylvania, with completion in 1923.
TYPICAL SECTIONS OF DAM	See Plate 4.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	Not available.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not available.
DESIGN REPORTS	None prepared.
GEOLOGY REPORTS	None prepared.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None reported.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None prepared.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported.
BORROW SOURCES	Unknown.
MONITORING SYSTEMS	None.
MODIFICATIONS	See Paragraph 6.1 (e) of the report.
HIGH POOL RECORDS	Not recorded (correspondence files indicate that during the 1936 flood, the spillway was flowing 19 inches deep).

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	Not maintained.
SPILLWAY PLAN SECTIONS DETAILS	See Plate 5.
OPERATING EQUIPMENT PLANS AND DETAILS	Not available.

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 1.9 square miles (woodlands)

ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 1990 - 92-acre feet

ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: 1922.1 - 131 acre-feet

ELEVATION; MAXIMUM DESIGN POOL: 1993

ELEVATION; TOP DAM: 1992.1 (measured low spot)

SPILLWAY:

a. Elevation 1990

b. Type Concrete overflow

c. Width 56 feet (perpendicular to flow direction)

d. Length Not applicable

e. Location Spillover Adjacent to spillway

f. Number and Type of Gates Not applicable

OUTLET WORKS:

a. Type 20-Inch cast iron pipe

b. Location Center of embankment

c. Entrance Inverts 1968 ±

d. Exit Inverts Unknown

e. Emergency Draindown Facilities 20-Inch pipe

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location None

c. Records None

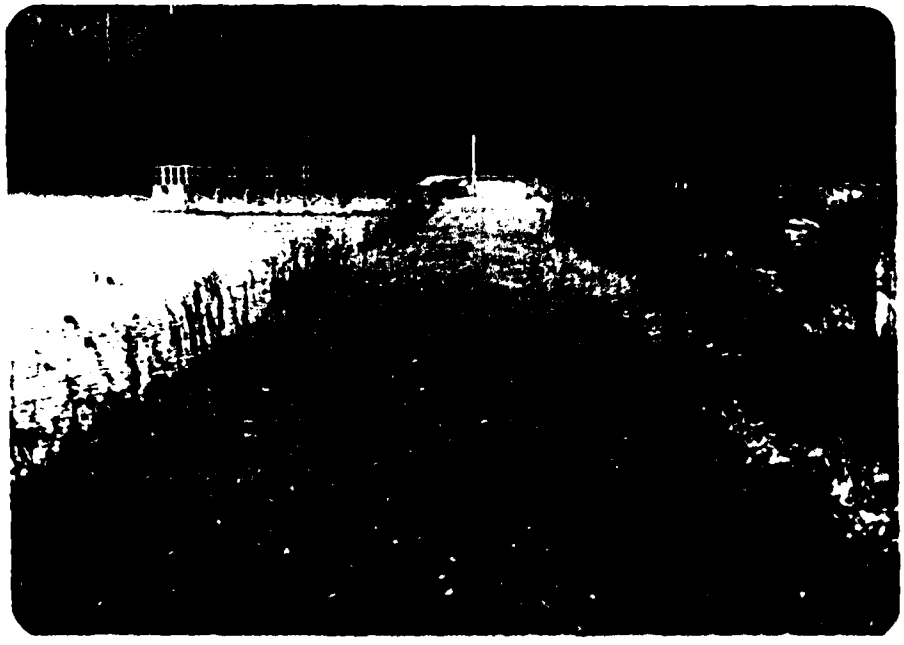
MAXIMUM NONDAMAGING DISCHARGE: 500 cfs ± (spillway capacity)

APPENDIX C

PHOTOGRAPHS

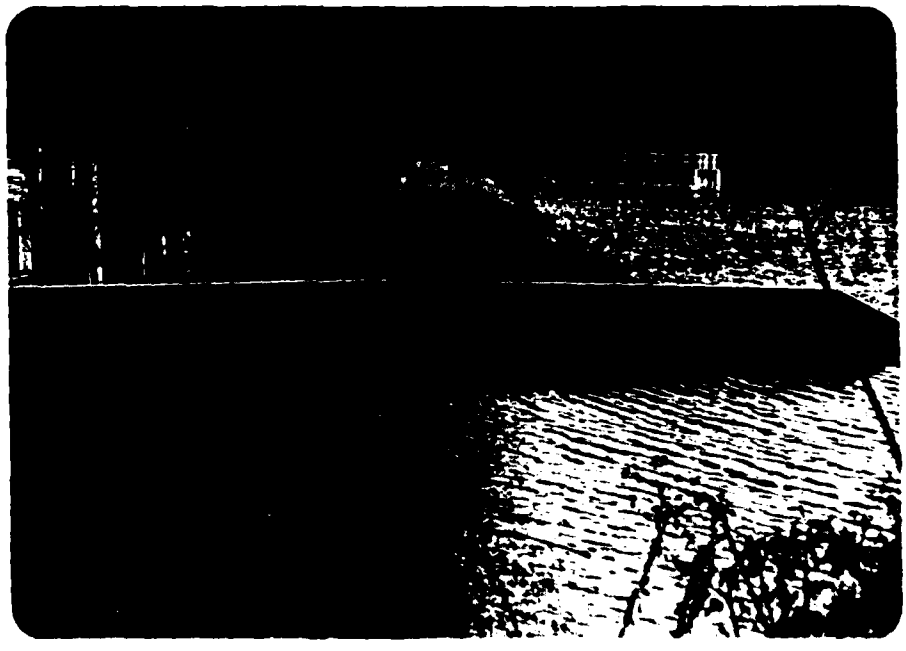
LIST OF PHOTOGRAPHS
EBENSBURG STORAGE DAM
NDI I.D. PA-422
NOVEMBER 14, 1979

PHOTOGRAPH NO.	DESCRIPTION
1	Dam crest, looking east.
2	Spillway crest.
3	Spillway approach channel, looking upstream.
4	Spillway discharge channel, looking downstream.
5	Intake tower.
6	A slump near the left abutment.
7	A slump near the right abutment.



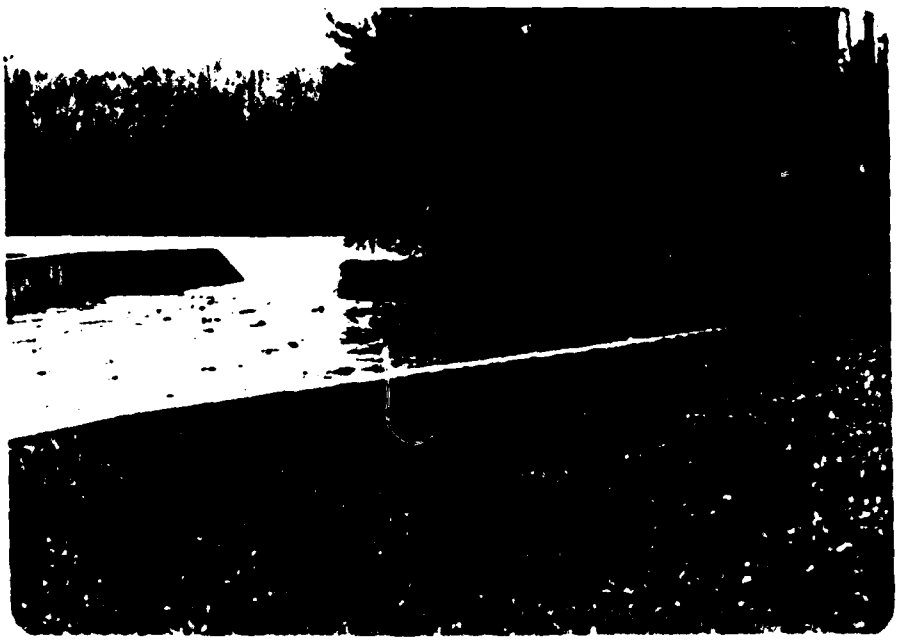
Photograph No. 1

Dam crest, looking east.



Photograph No. 2

Spillway crest.

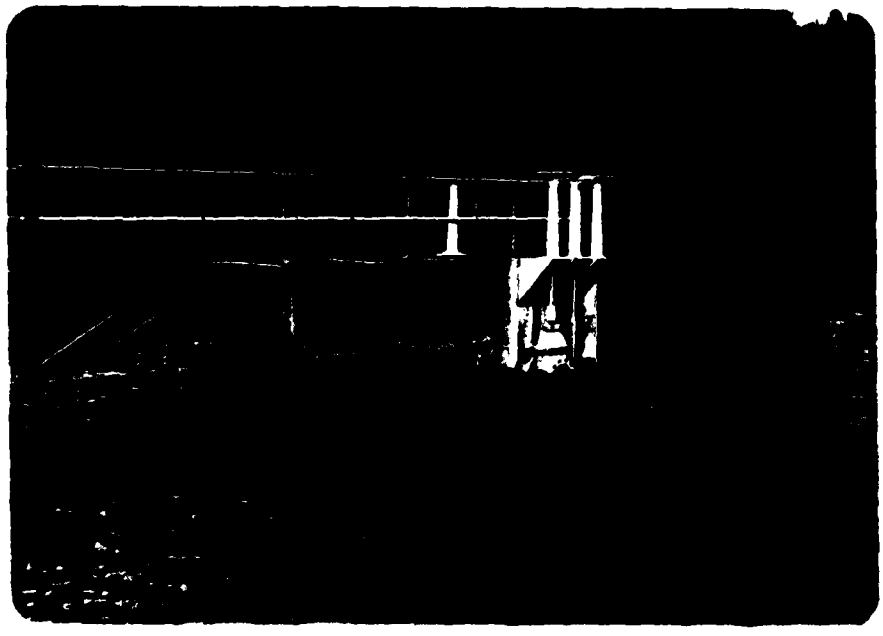


Photograph No. 3

Spillway approach channel, looking upstream.

Photograph No. 4

Spillway discharge channel, looking downstream.



Photograph No. 5

Intake tower.

Photograph No. 6

A slump near the left abutment.

Photograph No. 7

A slump near the right abutment.

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Ebensburg Storage Dam (NDI - I.D. PA 442)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.7 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	Howell's Run Reservoir	Howell's Run Dam	Ebensburg Reservoir	Ebensburg Storage Dam	
Drainage Area (square miles)	1.4	-	0.5	-	
Cumulative Drainage Area (square miles)	1.4	1.4	1.9	1.9	
Adjustment of PMF for Drainage Area (%)[2]					
6 Hours	102		102		
12 Hours	120		120		
24 Hours	130	-	130	-	
48 Hours	140		140		
72 Hours	-		-		
Snyder Hydrograph Parameters					
Zone[3]	24		24		
C_p/C_t[4]	0.45/1.6		0.45/1.6		
L (miles)[5]	1.8	-	1.0	-	
L_{ca} (miles)[5]	0.8		0.4		
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	1.8		1.2		
Spillway Data					
Crest Length (ft)		50		56	
Freeboard (ft)	-	8	-	2.1	
Discharge Coefficient		3.26 to 4.32		3.1	
Exponent		1.5		1.5	

[1] Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.
[2] Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.
[3] Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).
[4] Snyder's Coefficients.
[5] L = Length of longest water course from outlet to basin divide.
L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

STORAGE VS. ELEVATION (HOWELL'S RUN DAM)[4]

ELEVATION[3]	STORAGE (ACRE-FEET)[3]
2060	2076.0
2055	1794.4
2050	1324.3
Reservoir Bottom	0

STORAGE VS. ELEVATION (EBENSBURG STORAGE DAM)

ELEVATION	ΔH, FEET	AREA (ACRES)[1]	AVOLUME (ACRE-FEET)[2]	STORAGE (ACRE-FEET)
2000		30.2		279.0
	10		186.9	
1990	-	9.2		92.1
			92.1[3]	
Reservoir Bottom		-		0

[1] Planimetered from USGS maps.
[2] $\Delta Volume = \Delta H/3 \ (A_1 + A_2 + \sqrt{A_1 A_2})$.
[3] From PennDER files.
[4] Reference: Phase I Inspection Report, National Dam Inspection Program, Howell's Run Dam, NDI I.D. PA-434, June 1978.

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1                 A1       SNYDER UNIT HYDROGRAPH,FLOOD ROUTING AND DAM OVERTOPPING ANALYSES
    2                 A2       EBENSBURG OLD CITY RESERVIOR,CAMBRIA COUTY,NDI-I.D.PA.442.PROJ.79-543-10
    3                 A3       FOR 20%,30%,40%,50%,60%,70%,80%,90%,AND 100% PMF
    4                 B     500        0       10        0        0        0        0        0       -6        0
    5                 H1      5
    6                 J       1        9        1
    7                 J1   0.20     0.30     0.40     0.50     0.60     0.70     0.80     0.90     1.00
    8                 K       1        1                                          1
    9                 K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO HOWELLS RUN DAM(UPPER)
   10                 M       1        1     1.40              1.40                                    1
   11                 P               23.7      102      120      130      140
   12                 T                                                          1.0      .05             0.0938
   13                 W    1.78     0.45
   14                 X    -1.0    -0.05      2.0
   15                 K       1        2                                          1
   16                 K1       ROUTING FLOW THROUGH HOWELLS RUN DAM(NDI-I.D.PA.434)(UPPER)
   17                 Y                                         1        1
   18                 Y1      1                                                -2050.0       -1
   19                 Y42050.0  2050.5   2051.0   2051.5   2052.0   2052.5   2053.0   2053.5   2054.0   2054.5
   20                 Y42055.0  2055.5   2056.0   2058.0   2060.0
   21                 YS    0.0    57.6    169.5    322.4    510.5    731.3    984.6   1267.0   1572.0   1875.8
   22                 YS2264.0  2651.0   3057.6   4885.5   6827.7
   23                 $S    0.0  1324.0   1794.0   2076.0   2303.0
   24                 $E1997.0  2050.0   2055.0   2058.0   2060.0
   25                 $$2050.0
   26                 $D2050.0     3.08     1.50   670.0
   27                 $L   50.0   100.0    670.0
   28                 $V2058.0  2059.0   2060.0
   29                 K       3        2                                          1
   30                 K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO EBENSBURG OLD CITY DAM(LOWER)
   31                 M       1        1     0.50              1.90                                    1
   32                 P               23.7      102      120      130      140
   33                 T                                                          1.0      .05             0.0297
   34                 W    1.22     0.45
   35                 X    -1.0    -0.05      2.0
   36                 K       2        2                                          1
   37                 K1       COMBINED INFLOW HYDROGRAPH AT EBENSBURG OLD CITY RESERVOIR(LOWER)
   38                 K       1        3                                          1
   39                 K1       ROUTING FLOW THROUGH EBENSBURG OLD CITY RESERVOIR AND DAM(NDI-I.D.PA442)
   40                 Y                                         1        1
   41                 Y1      1                                                -1990.0
   42                 $S    0.0     92.1    279.0
   43                 $E1976.0  1990.0   2000.0
   44                 $$1990.0    56.0      3.1      1.5
   45                 $D1992.1     3.08     1.5    450.0
   46                 $L   20.0     70.0    120.0    225.0    275.0    325.0    425.0    450.0
   47                 $V1992.1  1992.3   1992.5   1992.6   1992.8   1993.1   1993.3   1994.7
   48                 K      99
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 .60	RATIO 6 .70	RATIO 7 .80	RATIO 8 .90	RATIO 9 1.00
HYDROGRAPH AT	1	1.40	1	595.	893.	1190.	1488.	1785.	2083.	2380.	2678.	2975.
	(	3.63)	(	16.85)(	25.28)(	33.70)(	42.13)(	50.55)(	58.98)(	67.40)(	75.83)(	84.26)
ROUTED TO	2	1.40	1	360.	592.	834.	1085.	1340.	1595.	1843.	2126.	2398.
	(	3.63)	(	10.20)(	16.75)(	23.63)(	30.73)(	37.93)(	45.16)(	52.19)(	60.20)(	67.89)
HYDROGRAPH AT	2	.50	1	259.	388.	517.	646.	776.	905.	1034.	1163.	1293.
	(	1.29)	(	7.32)(	10.98)(	14.64)(	18.30)(	21.96)(	25.62)(	29.28)(	32.94)(	36.60)
2 COMBINED	2	1.90	1	499.	815.	1147.	1490.	1838.	2193.	2538.	2910.	3290.
	(	4.92)	(	14.14)(	23.09)(	32.49)(	42.18)(	52.04)(	62.08)(	71.87)(	82.40)(	93.15)
ROUTED TO	3	1.90	1	488.	810.	1144.	1487.	1836.	2191.	2535.	2908.	3286.
	(	4.92)	(	13.81)(	22.94)(	32.40)(	42.10)(	52.00)(	62.03)(	71.79)(	82.35)(	93.04)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	2050.00	2050.00	2058.00
STORAGE	1324.	1324.	2076.
OUTFLOW	0.	0.	4886.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	2051.60	0.00	1474.	360.	0.00	44.00	0.00
.30	2052.18	0.00	1529.	592.	0.00	43.83	0.00
.40	2052.70	0.00	1578.	834.	0.00	43.67	0.00
.50	2053.18	0.00	1623.	1085.	0.00	43.50	0.00
.60	2053.62	0.00	1664.	1340.	0.00	43.33	0.00
.70	2054.04	0.00	1704.	1595.	0.00	43.33	0.00
.80	2054.45	0.00	1742.	1843.	0.00	43.33	0.00
.90	2054.82	0.00	1777.	2126.	0.00	43.17	0.00
1.00	2055.17	0.00	1810.	2398.	0.00	43.17	0.00

ROUTING THROUGH UPSTREAM DAM

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1990.00	1990.00	1992.10
STORAGE	92.	92.	131.
OUTFLOW	0.	0.	528.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1991.99	0.00	129.	488.	0.00	43.33	0.00
.30	1992.63	.50	141.	810.	5.83	43.00	0.00
.40	1992.91	.81	147.	1144.	8.00	42.83	0.00
.50	1993.15	1.05	151.	1487.	9.50	42.83	0.00
.60	1993.34	1.24	155.	1836.	10.63	42.67	0.00
.70	1993.51	1.41	158.	2191.	11.50	42.67	0.00
.80	1993.66	1.56	160.	2535.	11.83	42.67	0.00
.90	1993.81	1.71	163.	2908.	12.17	42.67	0.00
1.00	1993.95	1.85	166.	3286.	12.50	42.50	0.00

ROUTING THROUGH EBENSBURG STORAGE DAM

OVERTOPPING ANALYSIS SUMMARY

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  17 JAN 81
**********
    1                 A1       SNYDER UNIT HYDROGRAPH,FLOOD ROUTING AND DAM OVERTOPPING ANALYSES
    2                 A2       EBENSBURG OLD CITY RESERVIOR,CAMBRIA COUTY,NDI-I.D.PA.442.PROJ.79-543-10
    3                 A3       FOR 20%,30%,40%,50%,60%,70%,80%,90%,AND 100% PMF
    4                 B     300         0        15         0         0         0         0         0        -4         3
    5                 J1      5
    6                 J       1         0         1
    7                 J1   0.20      0.30      0.40      0.50      0.60      0.70      0.80      0.90      1.00
    8                 K       0         1                                                 1
    9                 K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO HOWELLS RUN DAM(UPPER)
   10                 A       1         1      1.40                 1.40                                        1
   11                 P                23.7       102       120       130       140
   12                 T                                                                 1.0       .05                 0.0938
   13                 W    1.78      0.45
   14                 X    -1.0     -0.05       2.0
   15                 K       1         2                                                 1
   16                 K1       ROUTING FLOW THROUGH HOWELLS RUN DAM(NDI-I.D.PA.434)(UPPER)
   17                 Y                                       1         1
   18                 Y1      1                                                      -2050.0       -1
   19                 Y42050.0  2050.5    2051.0    2051.5    2052.0    2052.5    2053.0    2053.5    2054.0    2054.5
   20                 Y42055.0  2055.5    2056.0    2058.0    2060.0
   21                 Y5    0.0      57.6      169.5     322.4     510.5     731.3     984.6    1267.0    1572.0    1875.8
   22                 Y52264.0  2651.0    3057.6    4885.5    6827.7
   23                 SS    0.0    1324.0    1794.0    2076.0    2303.0
   24                 SE1997.0  2050.0    2055.0    2058.0    2060.0
   25                 SS2050.0
   26                 SD2058.0     3.08      1.50     670.0
   27                 SL   50.0     100.0     670.0
   28                 SV2058.0  2059.0    2060.0
   29                 K       0         3                                                 1
   30                 K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO EBENSBURG OLD CITY DAM(LOWER)
   31                 A       1         1      0.50                 1.90                                        1
   32                 P                23.7       102       120       130       140
   33                 T                                                                 1.0       .05                 0.0297
   34                 W    1.22      0.45
   35                 X    -1.0     -0.05       2.0
   36                 K       2         3                                                 1
   37                 K1       COMBINED INFLOW HYDROGRAPH AT EBENSBURG OLD CITY RESERVOIR(LOWER)
   38                 K       1         4                                                 1
   39                 K1       ROUTING FLOW THROUGH EBENSBURG OLD CITY RESERVOIR AND DAM(NDI-I.D.PA442)
   40                 Y                                       1         1
   41                 Y1      1                                                      -1990.0
   42                 SS    0.0      92.1     279.0
   43                 SE1976.0  1990.0    2000.0
   44                 SS1990.0     56.0       3.1       1.5
   45                 SD1992.1     3.08       1.5     450.0
   46                 SL   20.0      75.0     120.0     225.0     275.0     325.0     425.0     450.0
   47                 SV1992.1  1992.3    1992.5    1992.6    1992.8    1993.1    1993.3    1994.7
   48                 K       0         5                                                 1
   49                 K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO RAILROAD EMBANKMENT
   50                 A       1         1     0.072                 1.972                                        1
```


COMPUTER INPUT OVERTOPPING ANALYSIS
(INCLUDING D/S RR. EMBANKMENT)

```
51          P            23.7      102       120.      130.      140
                                                                          1.0       .05              0.0002
52          T
53          W   0.61     0.45
54          X   -1.0     -0.05     2.0
55          K      2         5                                                    1
56          K1       COMBINED INFLOW HYDROGRAPH AT RAILROAD EMBANKMENT CULVERT
57          K      1         6                                                    1
58          K1       ROUTING FLOW THROUGH RAILROAD EMBANKMENT CULVERT
59          V                                      1         1
60          Y1       1                                                      -1968.0       -1
61          Y41968.0  1970.0    1970.5    1971.0    1971.5    1972.0    1972.5    1973.0    1974.0    1975.0
62          Y41976.0  1978.0    1980.0    1982.0    1984.0    1988.0    1990.0    2000.0
63          Y5    0.0      30.0      40.0      60.0      77.0      96.0     115.0     135.0     171.0     205.0
64          Y5  230.0     260.0     310.0     350.0     380.0     440.0     460.0     560.0
65          S5    0.0      14.8     209.8
66          SE1968.0  1980.0    2000.0
67          SS1968.0
68          SD1968.0     3.08       1.5     700.0
69          K     99
```

COMPUTER INPUT OVERTOPPING ANALYSIS
(INCLUDING D/S RR. EMBANKMENT)
CONTINUED

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1968.00	1968.00	1988.00
STORAGE	0.	0.	93.
OUTFLOW	0.	0.	440.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1984.28	0.00	56.	384.	0.00	46.25	0.00
.30	1992.79	4.79	139.	671.	8.50	45.25	0.00
.40	1993.29	5.29	144.	1188.	11.25	43.00	0.00
.50	1993.53	5.53	147.	1576.	12.50	42.00	0.00
.60	1993.70	5.70	148.	1892.	13.75	42.50	0.00
.70	1993.87	5.87	150.	2260.	14.75	42.50	0.00
.80	1994.04	6.04	152.	2619.	15.50	42.50	0.00
.90	1994.19	6.19	153.	2996.	16.50	42.50	0.00
1.00	1994.35	6.35	155.	3394.	17.00	42.50	0.00

COMPUTER INPUT OVERTOPPING ANALYSIS
(THROUGH D/S RR. EMBANKMENT)

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By LNTC Date 1/4/80 Subject EBENSBURG STORAGE DAM Sheet No. 1 of 4
Chkd. By [illegible] Date 1/25/80 Proj. No. 79-543-10

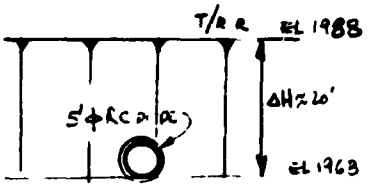
HYDRAULIC FEATURES OF D/S RR EMBANKMENT & CULVERT

REF HOWELLS RUN DAM INSPECTION REPORT 1978 By D'App

FROM FIELD SURVEY MAY 78

Top of R R EMBANKMENT IS ABOUT

5' BELOW OLD CITY RESERVOIR DAM



OLD CITY RESERVOIR LAKE LEVEL EL 1990 (FROM USGS MAP)
FREEBOARD ≈ 3
TOP DAM EL 1993
LESS 5' 5'
TOP OF R.R. EMBANKMENT 1988
ΔH ≈ 20'
PIPE INV ELEVATION 1968

STORAGE Vs ELEVATION.

ELEVATION	AREA, ACRES	ΔH	ΔV AC-ft	ΣV AC-ft
1968	≈ 0	12	14.8	0
1980	$0.04 \times \left(\frac{2000}{5280}\right)^2 \times 640 = 3.7$	20	195.0	14.8
2000	$0.19 \times \left(\frac{2000}{5280}\right)^2 \times 640 = 17.5$			209.8

WATERSHED AREA BETWEEN R/R & DAM

$A = 0.5 \times \left(\frac{2000}{5280}\right)^2 = 0.072^{SM} = 46$ acres

$L = .04^{mile}$; $L_{ca} = 0.1^{mile}$ $t_p = 1.6[(.04)(0.1)]^{.03} = 0.61^{hr}$

$C_p = 0.45$

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By WTC Date 1/9/80 Subject EBENSBURG STORAGE DAM Sheet No. 2 of 4
Chkd. By MS Date 1/28/80 Proj. No. 79-543-10

5' ϕ RCP CAPACITY

Assume 1% slope 1:20 in 2.

$H_T = H + 1.2 - 0.85 D_5$
$= H - 3.05' = H - 3'$

REF. DESIGN OF SMALL DAM 2nd EDITION

ELEVATION	H FT	$\frac{H}{D}$	Q_{INLET}	
1968	0	0	0	
	0.5	0.1	—	
	1.0	0.2	—	
	1.5	0.3	—	
1970	2.0	0.4	±30	
	2.5	0.5	40	
1971	3.0	0.6	60	
	3.5	0.7	77	
1972	4.0	0.8	96	
	4.5	0.9	115	
1973	5.0	1.0	135.	
1974	6.0	1.2	171	
1975	7.0	1.4	205	
1976	8.0	1.6	230	
1978	10.0	2.0	280	
1980	12.0	2.4	310	
1982	14.0	2.8	350	
1984	16.0	3.2	380	
1988	20.0	4.0	440	
1990	22.0	4.4	460	
2000	32.0	6.4	560	

CHECK $Q_{OUT} = 115\sqrt{H-3}$ FOR OUTLET CONTROL

—	
81	
115	
141	
163	
199	
~~230~~	CHECK FOR
257	OUTLET CONTROL
304	NOT APPLICABLE
345	INLET GOVERNED
381	
414	
474	
501	
619	

$$H_T = \left[\frac{2.5204\,(Hk_e)}{D^4} + \frac{466.18\,n^2 L}{D^{16/3}}\right]\left(\frac{Q}{10}\right)^2 \qquad \text{Ref. P. 567}$$

$$= \left[\frac{2.5204\,(1.5)}{5^4} + \frac{(466.18)(0.012)^2(120)}{5^{16/3}}\right]\left(\frac{Q}{10}\right)^2$$

$Q = 115.04\sqrt{H_T}$ Say $Q = 115\sqrt{H-3}$

D 9 of 11

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By WJC Date 1/4/80 Subject EBENSBURG STORAGE DAM Sheet No. 3 of 4
Chkd. By [illegible] Date 1/28/80 Proj. No. 79-543-10

Hydraulic Computations

563

To use scale (1) or (3), pivot between appropriate point on (2), then use straight edge

line through D and Q scales, or reverse as required.

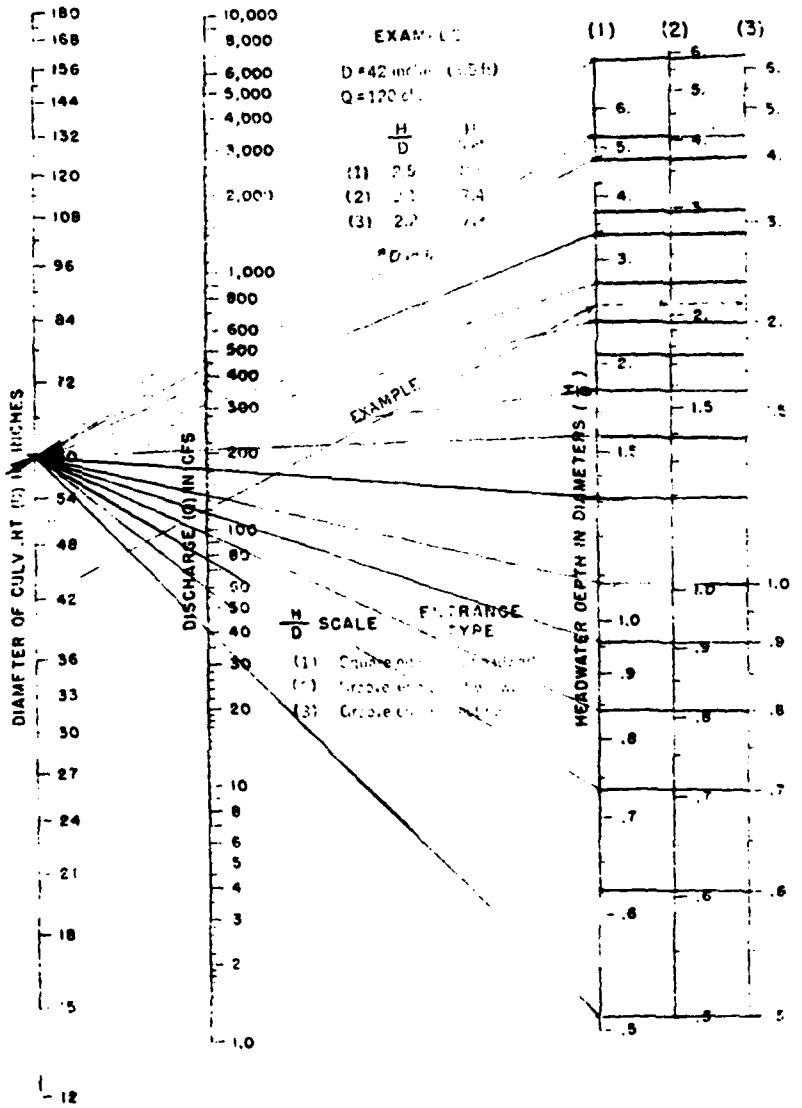
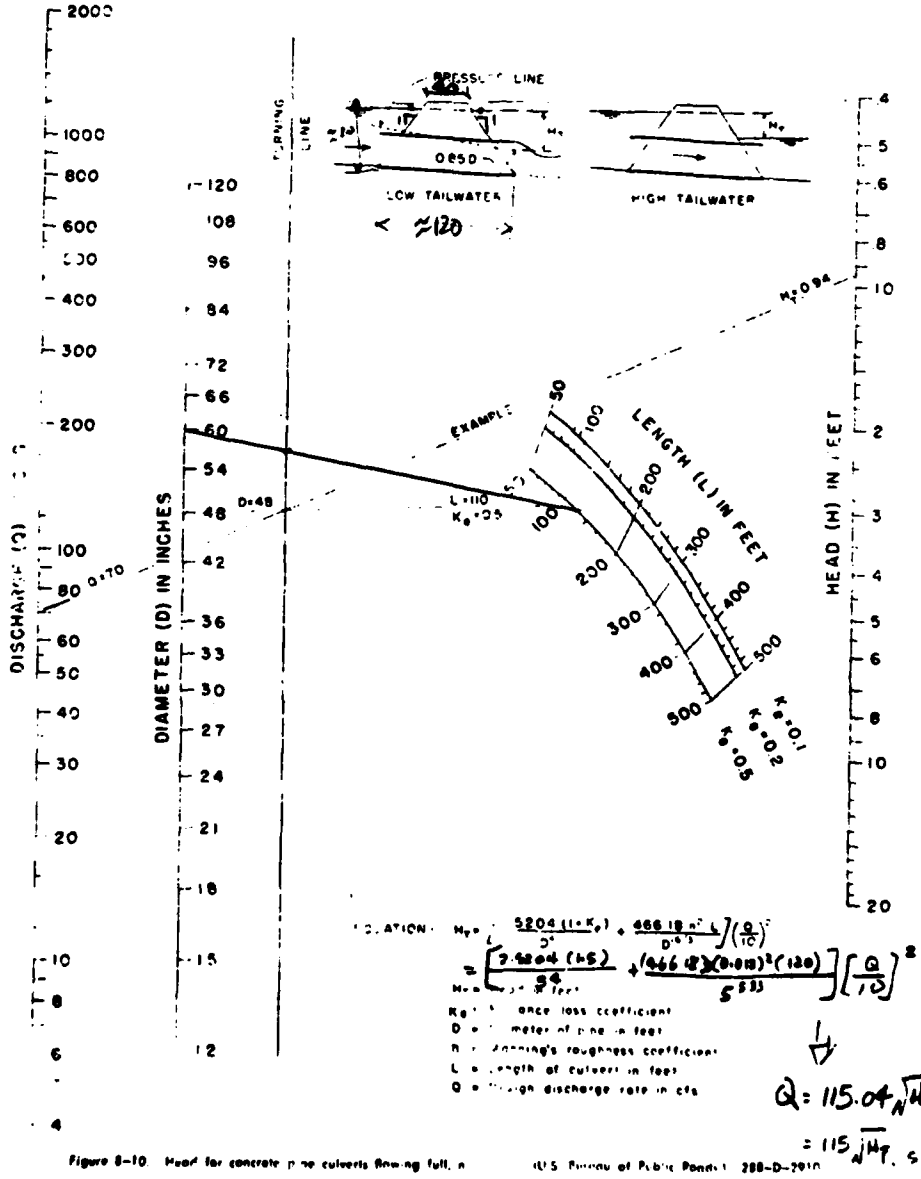


Figure 5-F Headwater depth for concrete pipe culverts with entrance control [illegible] Bureau of Public Roads, January 1963

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By LJTC Date 1/4/80 Subject EBENSBURG STORAGE DAM Sheet No. 4 of 4
Chkd. By MG Date 1/25/80 Proj. No. 79-543-10

Hydraulic Computations 567



$$H_e = \frac{5.04(1+K_e)}{D^4} + \frac{466.18\,n^2 L}{D^{5.33}} \left(\frac{Q}{10}\right)^2$$

$$= \left[\frac{5.04(1+.5)}{48^4} + \frac{466.18(.013)^2(110)}{48^{5.33}}\right]\left[\frac{Q}{10}\right]^2$$

H_e = Entrance loss coefficient
D = Diameter of pipe in feet
n = Manning's roughness coefficient
L = Length of culvert in feet
Q = Design discharge rate in cfs

$$Q = 115.04\sqrt{H_T}$$

$$= 115\sqrt{H_T}, \text{ say}$$

Figure 8-10. Head for concrete pipe culverts flowing full, n (U.S. Bureau of Public Roads) 288-D-2910

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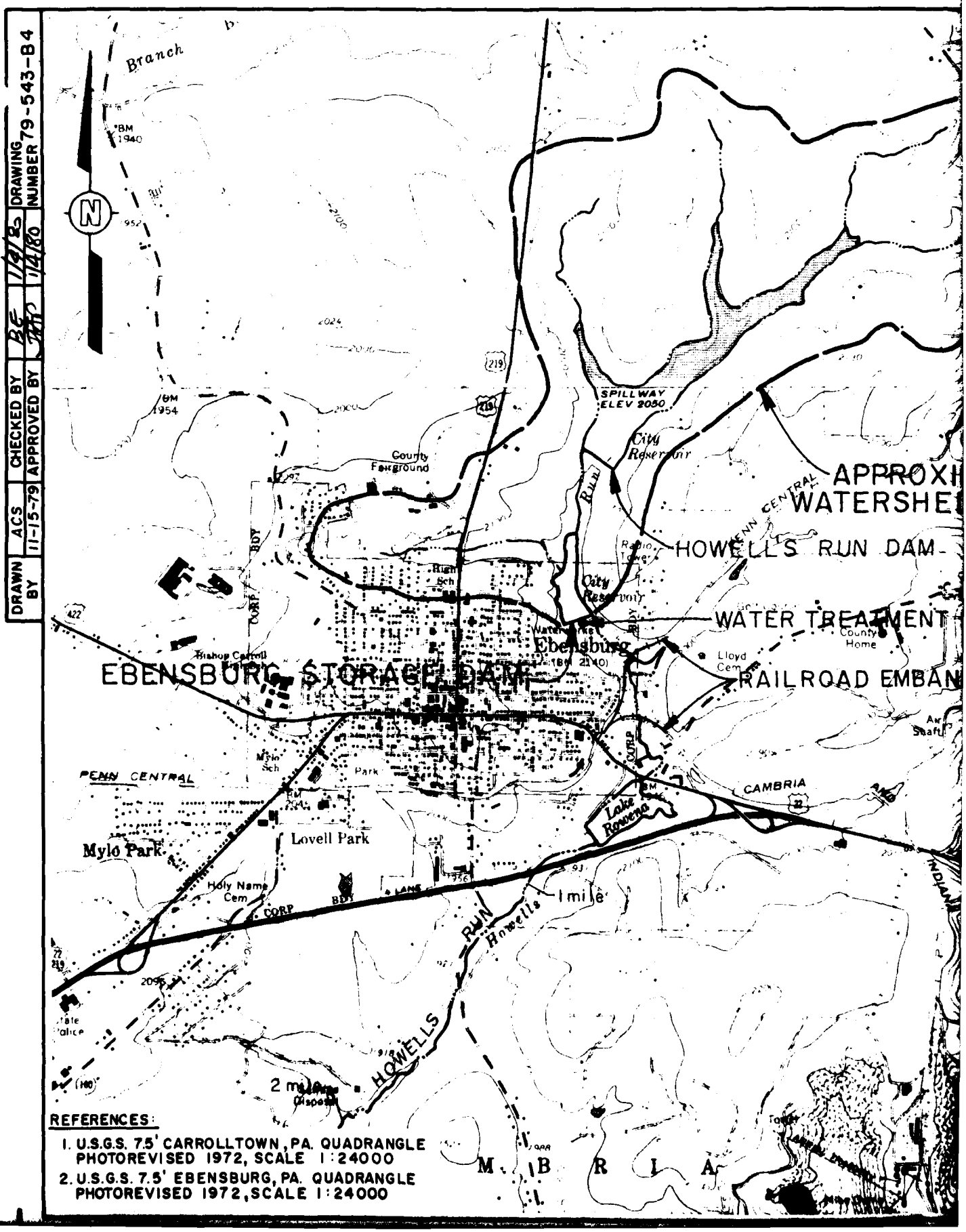
D11 OF 11

APPENDIX E

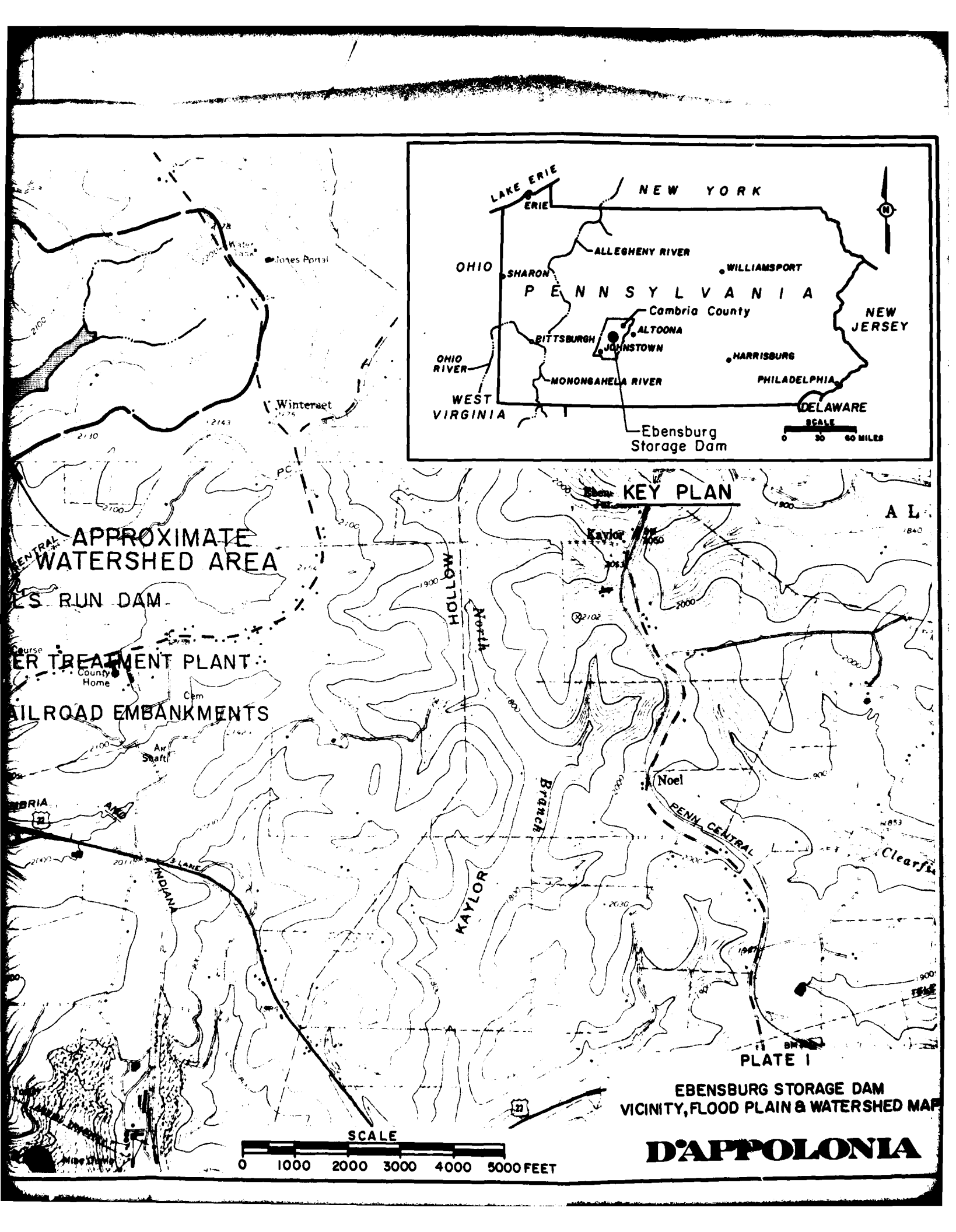
PLATES

DRAWN BY	ACS	CHECKED BY	BE	11/9/80	DRAWING NUMBER 79-543-B4
	11-15-79	APPROVED BY	[illegible]	11/9/80	

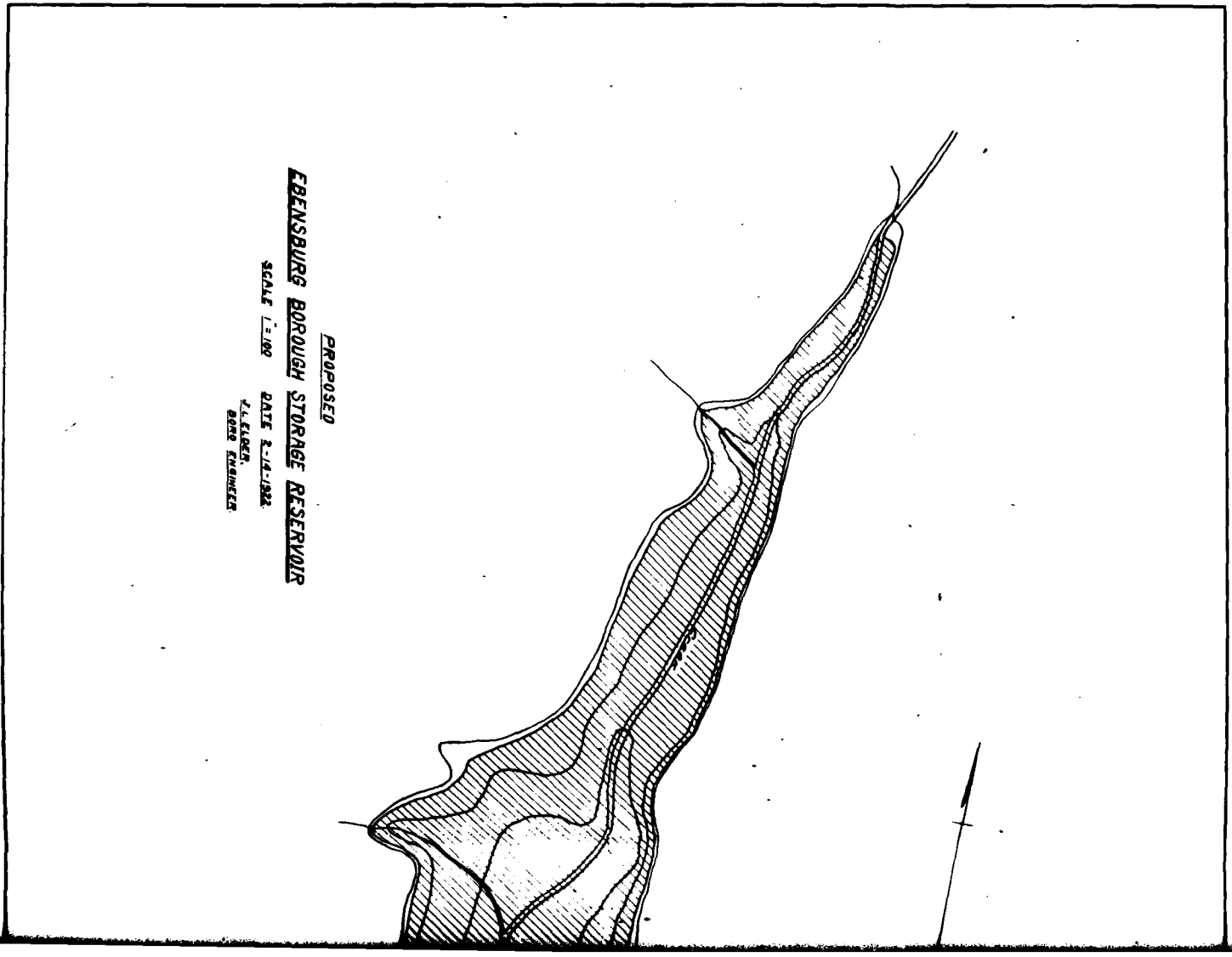


REFERENCES:

1. U.S.G.S. 7.5' CARROLLTOWN, PA. QUADRANGLE PHOTOREVISED 1972, SCALE 1:24000
2. U.S.G.S. 7.5' EBENSBURG, PA. QUADRANGLE PHOTOREVISED 1972, SCALE 1:24000


KEY PLAN
LAKE ERIE
ERIE
NEW YORK
ALLEGHENY RIVER
OHIO
SHARON
WILLIAMSPORT
PENNSYLVANIA
Cambria County
NEW JERSEY
ALTOONA
PITTSBURGH
JOHNSTOWN
HARRISBURG
OHIO RIVER
MONONGAHELA RIVER
PHILADELPHIA
WEST VIRGINIA
DELAWARE
Ebensburg Storage Dam
SCALE
0 30 60 MILES
APPROXIMATE WATERSHED AREA
S RUN DAM
ER TREATMENT PLANT
AILROAD EMBANKMENTS
Jones Portal
Winterset
Kaylor
HOLLOW
North
Branch
KAYLOR
Noel
PENN CENTRAL
INDIANA
Clearfield
SCALE
0 1000 2000 3000 4000 5000 FEET
PLATE I
EBENSBURG STORAGE DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP
D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	1/3/80	DRAWING NUMBER 79-543-B5
	1-2-80	APPROVED BY	JHD	1/4/80	



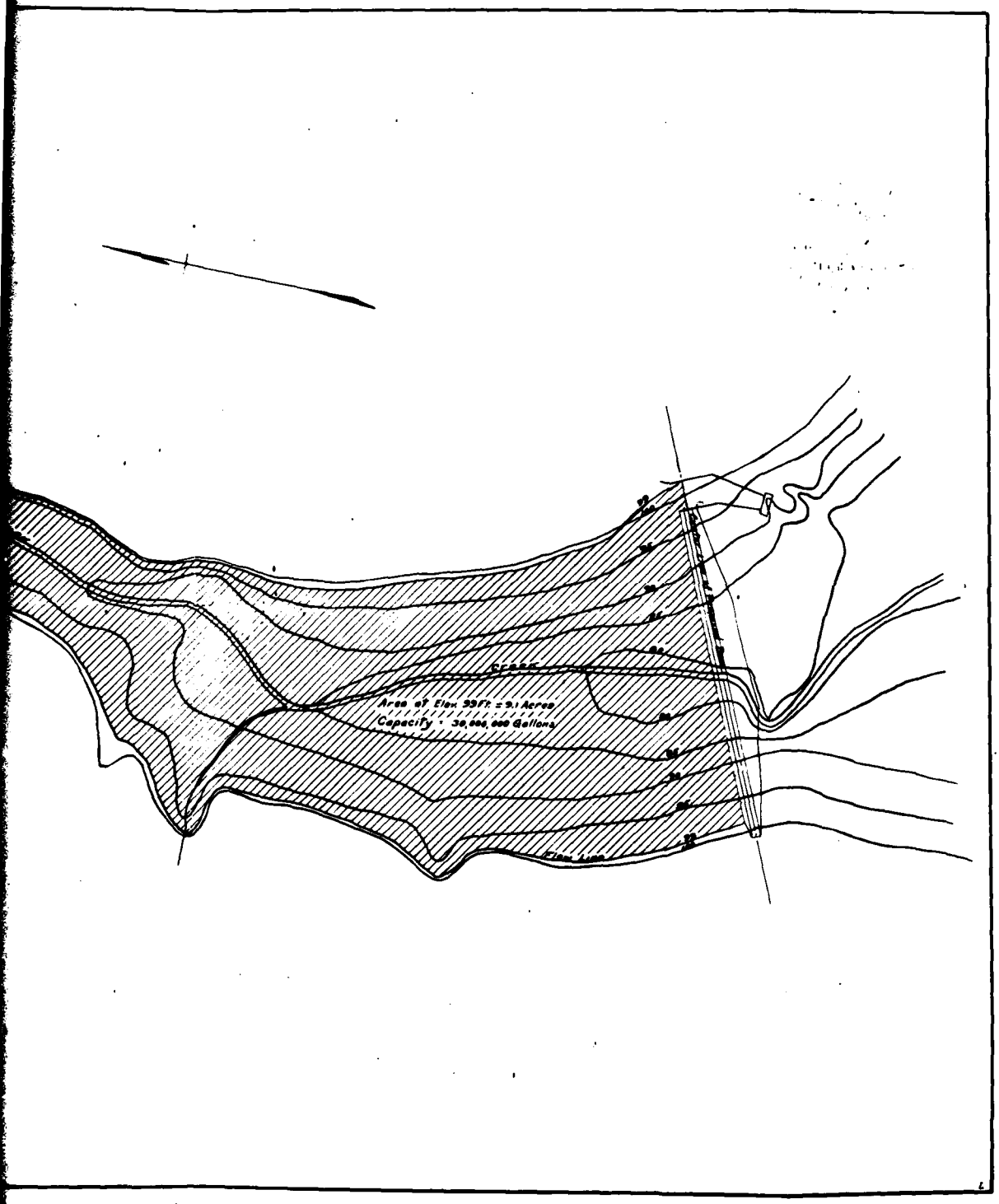


PLATE 2

D'APPOLONIA

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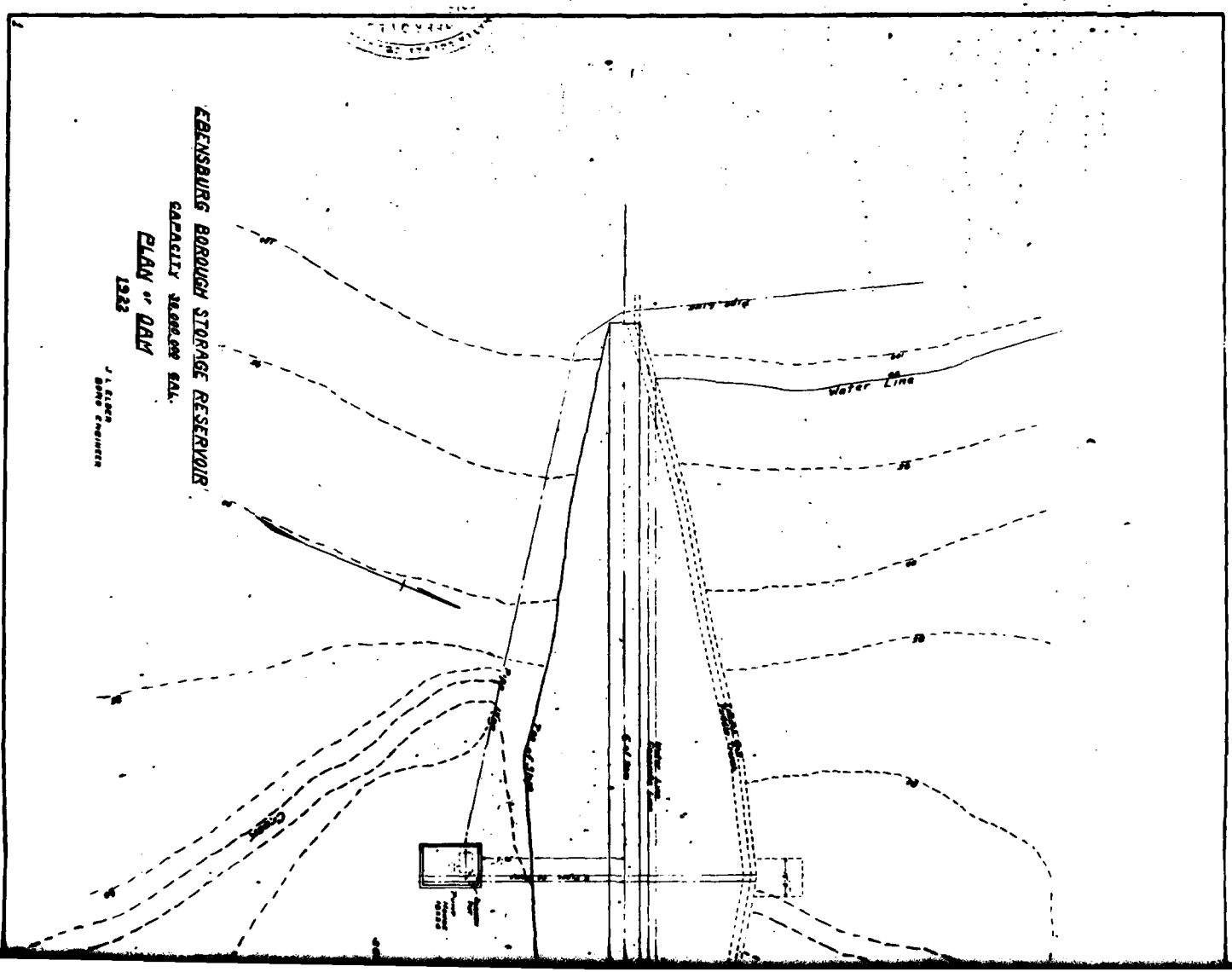
	1-2-80	APPROVED BY	[illegible]	1/14/80		



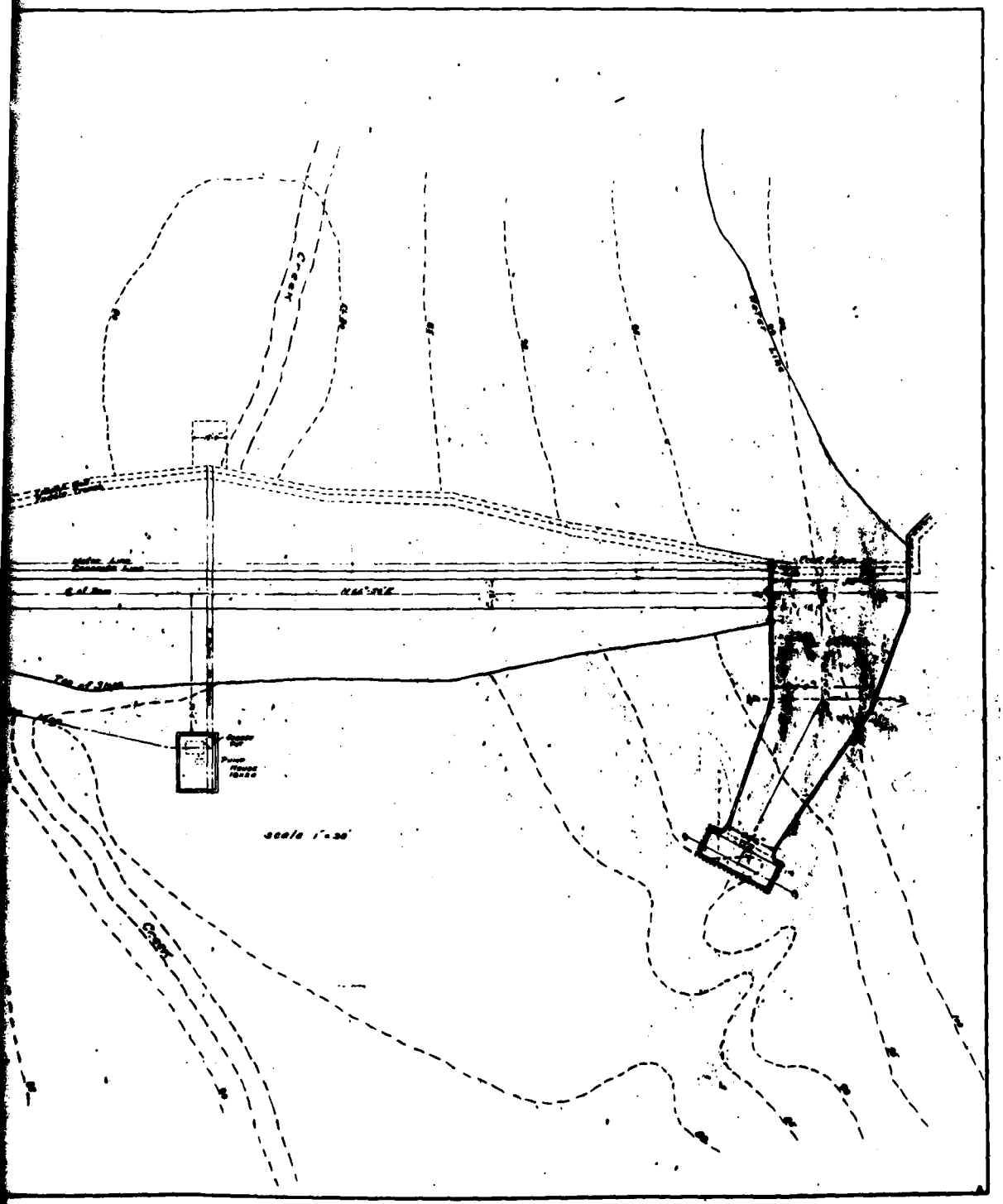
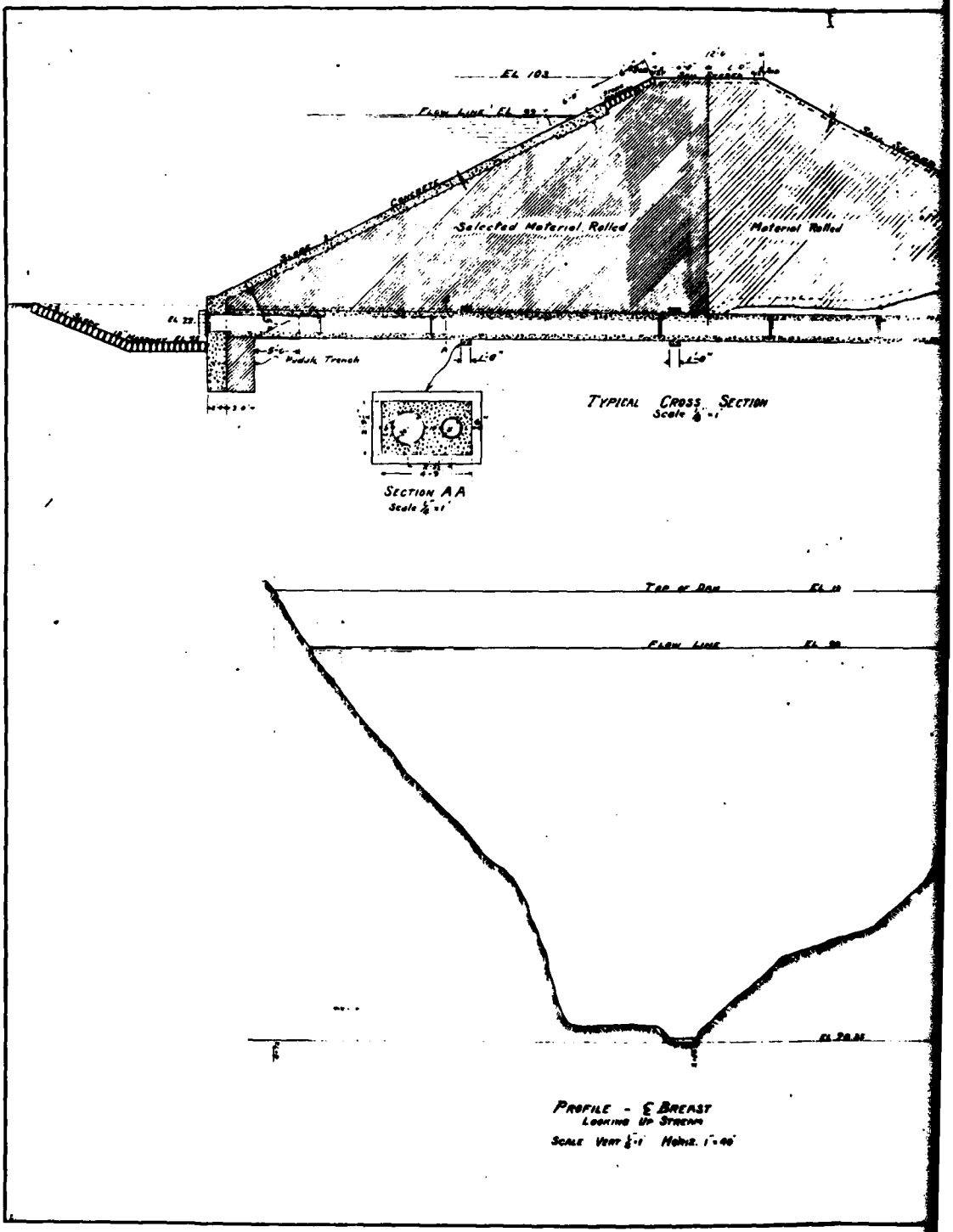


PLATE 3

DRAWN BY	ACS	CHECKED BY		1/4/80	DRAWING NUMBER 79-543-B7
	1-2-80	APPROVED BY		1/14/80	



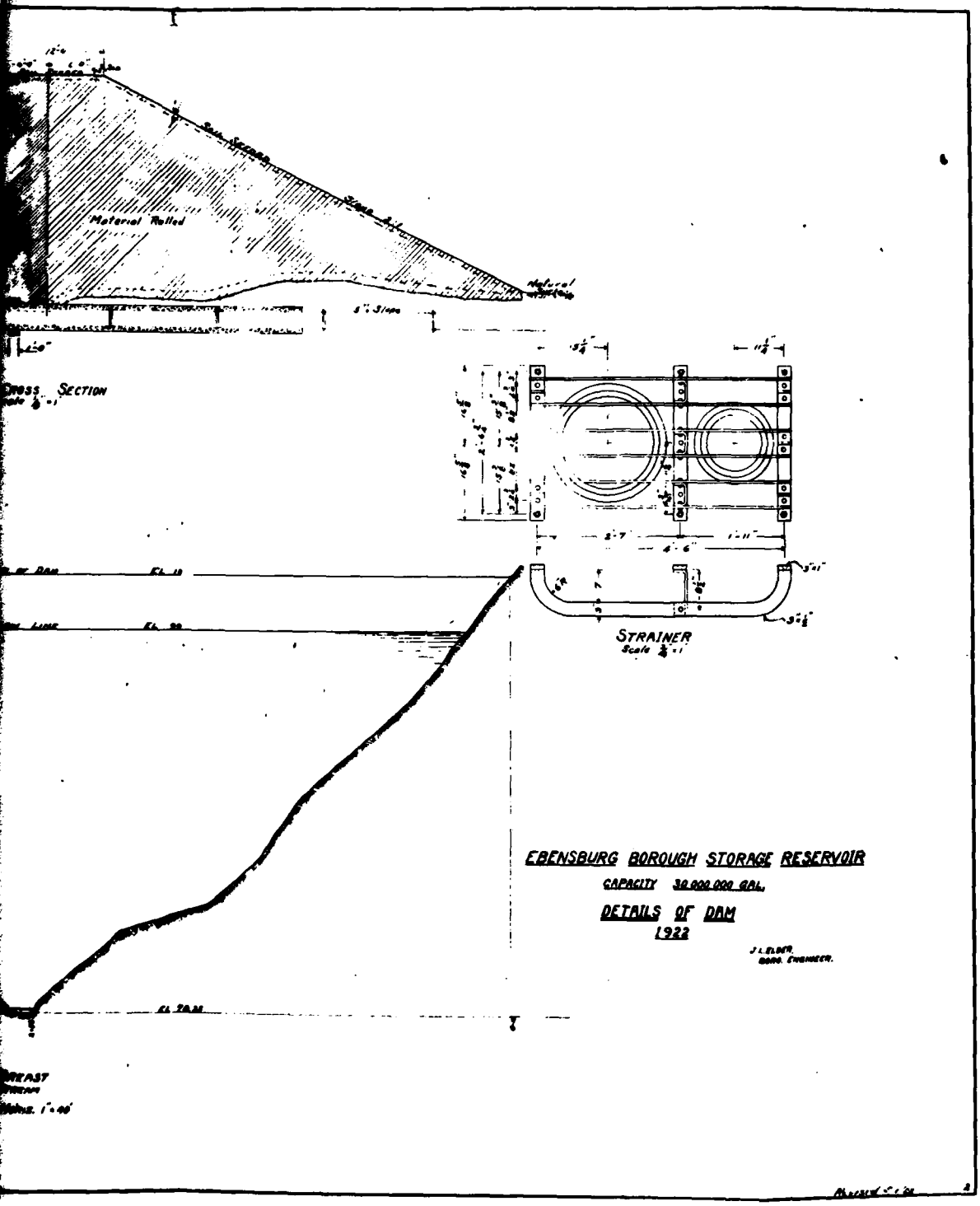
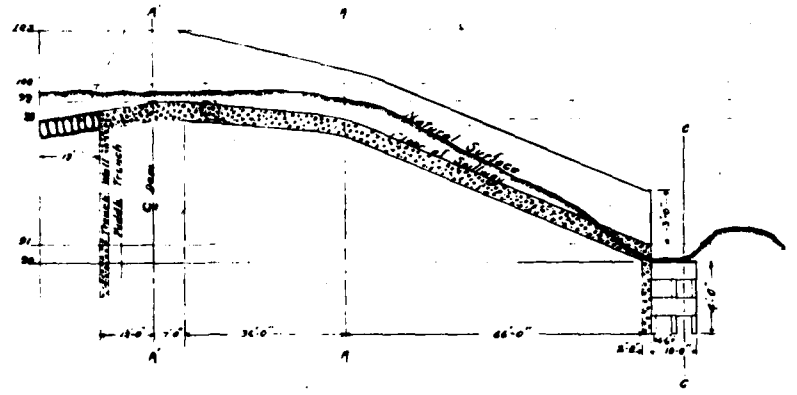
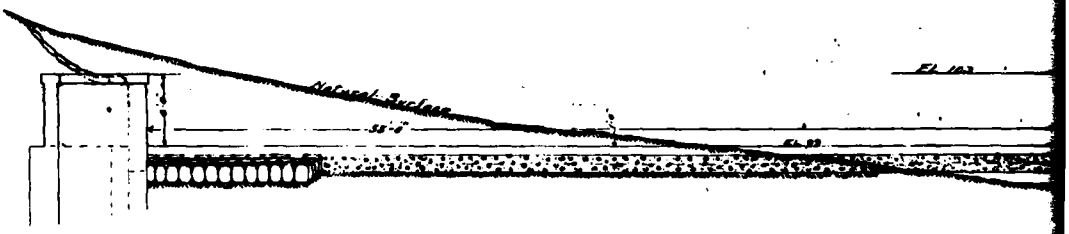


PLATE 4

DRAWN BY	ACS	CHECKED BY		DRAWING NUMBER 79-543-88
	1-2-80	APPROVED BY		

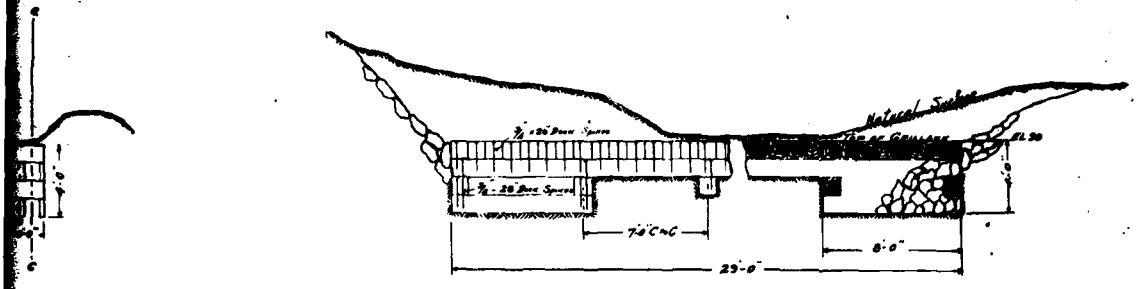


PROFILE ALONG ℄ OF SPILLWAY
SCALE: HOR 1"=20' VER 1"=5'

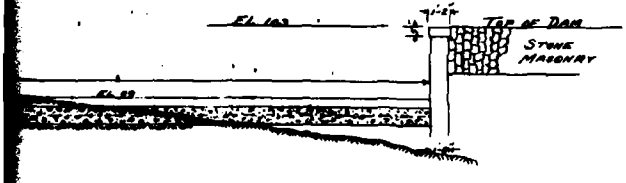


ELEVATION AT ℄ OF DAM
LOOKING DOWN SPILLWAY
SCALE 1"=5'

SECTION AT A-A
SCALE 1"=5'



SECTION AT C-C
SCALE 1"=5'



EBENSBURG BOROUGH STORAGE RESERVOIR

CAPACITY 20,000,000 GAL.

DETAILS OF SPILLWAY

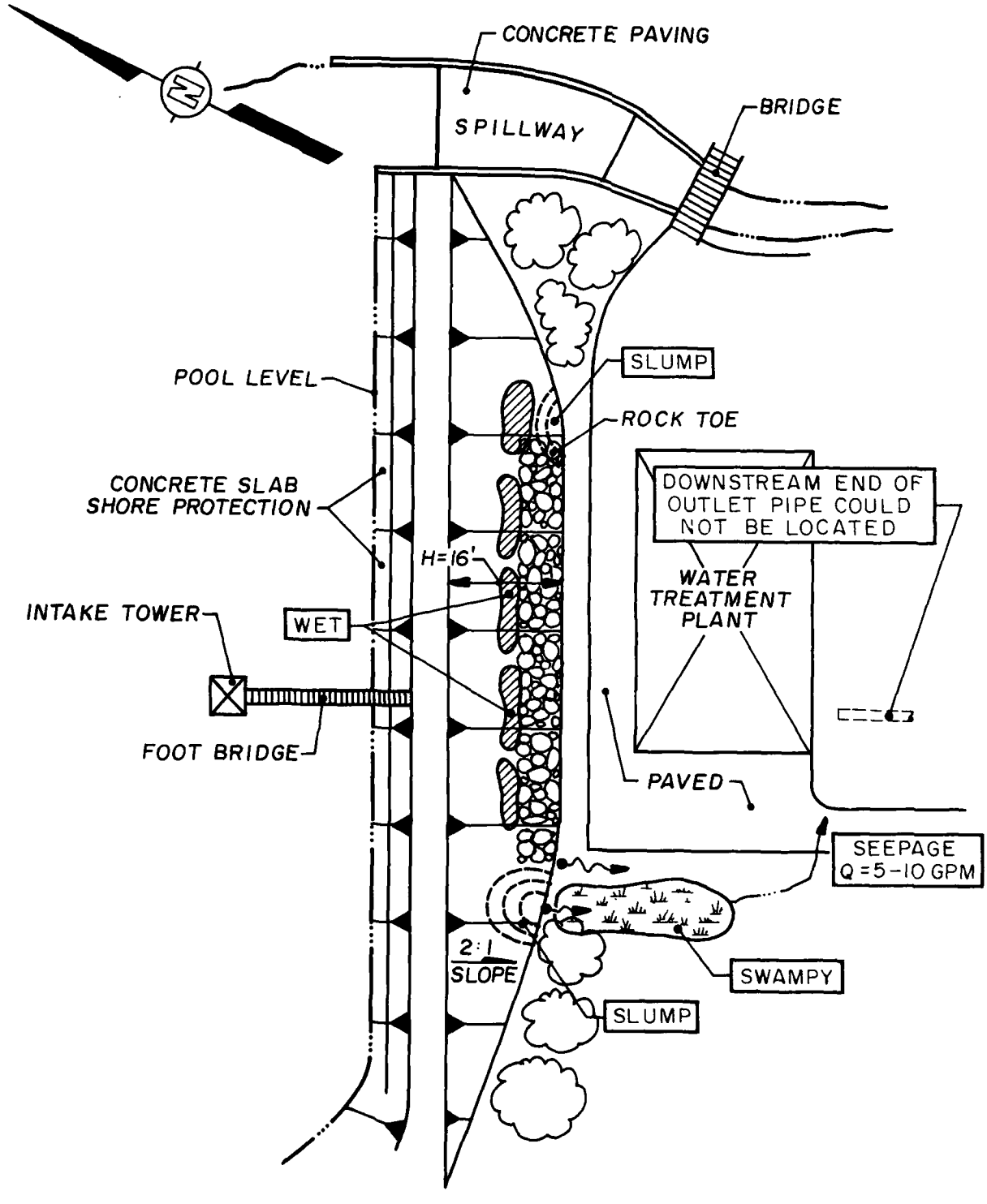
1922

J.L. CLARK
BORO ENGINEER

3

PLATE 5

DRAWN BY	ACS	CHECKED BY		DRAWING NUMBER 79-343-A3
	12-5-79	APPROVED BY		



NOTES:

1. POOL LEVEL DATE OF INSPECTION: AT SPILLWAY CREST

NOT TO SCALE

PLATE 6

EBENSBURG STORAGE DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: NOV. 14, 1979

DAPPOLONIA

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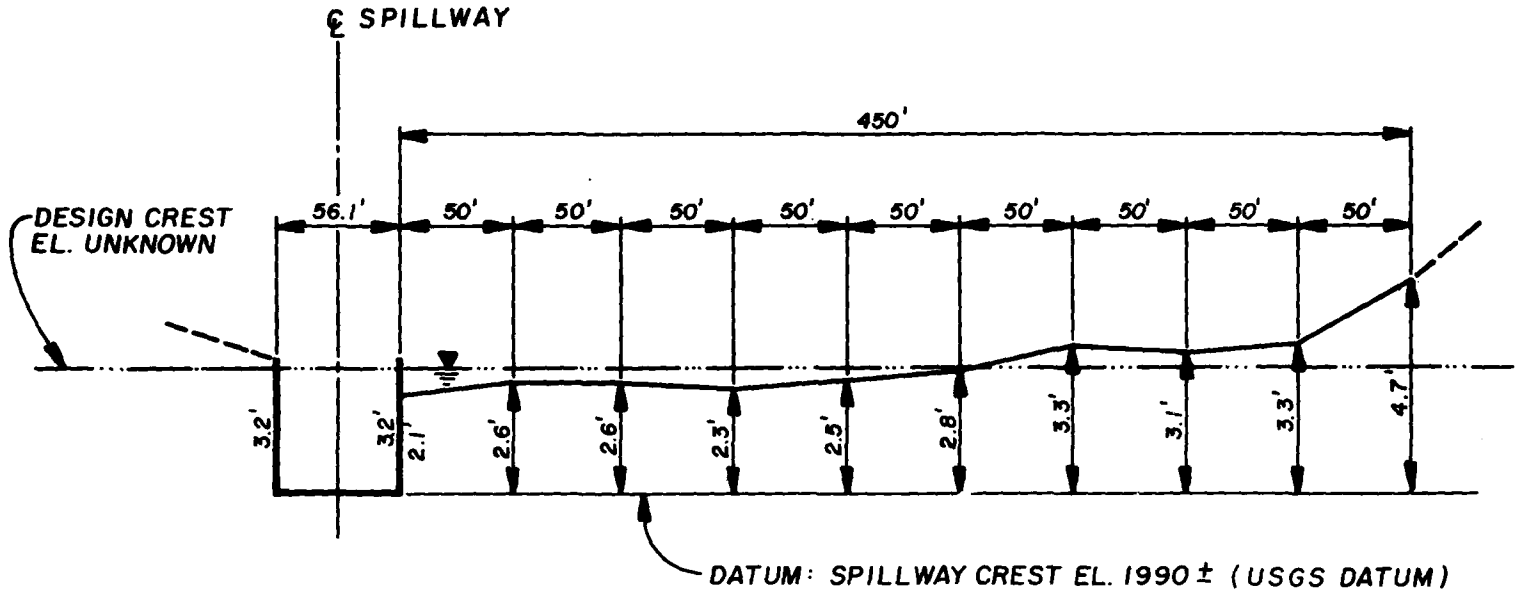
	11-30-79	APPROVED BY			



DAM CREST PROFILE
(LOOKING DOWNSTREAM)

NOTES:

1. DAM CREST IS SURVEYED RELATIVE TO SPILLWAY CREST LEVEL.
2. DATUM ELEVATION IS INTERPOLATED FROM USGS MAPS, THEREFORE IS APPROXIMATE.

D'APPOLONIA

EBENSBURG STORAGE DAM
DAM CREST SURVEY
FIELD INSPECTION DATE: NOV. 14, 1979

PLATE 7

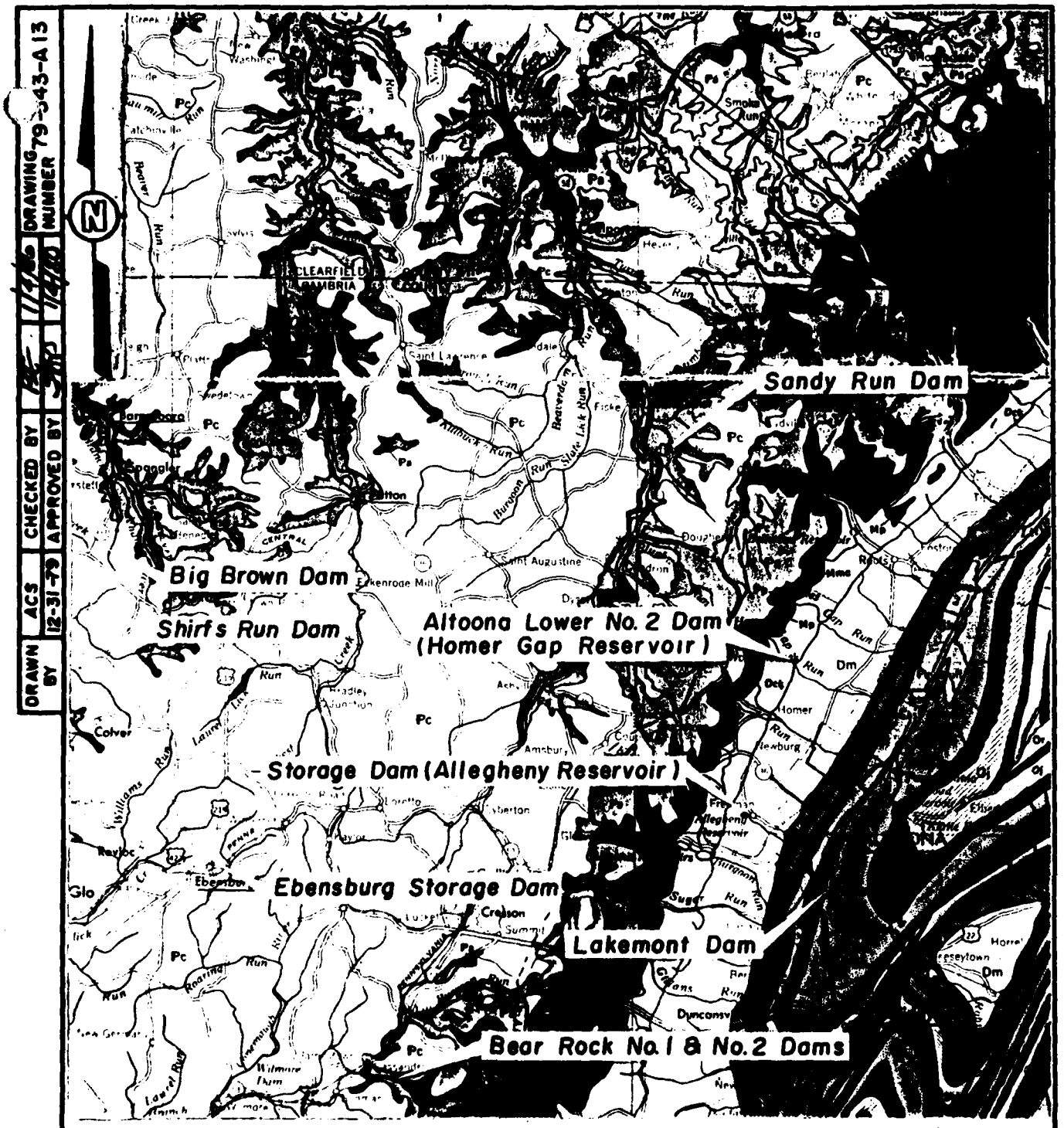
APPENDIX F

REGIONAL GEOLOGY

APPENDIX F
REGIONAL GEOLOGY

The Ebensburg Storage Dam is located approximately two miles west of the Allegheny Front on the east limb of the Wilmore Syncline. Dip of the strata averages five degrees to the northwest toward the axis of the Wilmore Syncline. Rocks at the site belong to the Allegheny and Pottsville formations of the Pennsylvanian System. The Allegheny is composed of sandstones, shales, thin limestones, and several coal seams, most notably the Lower Freeport and Upper and Lower Kittanning. The Pottsville Formation lies beneath the Allegheny and is composed of the Homewood Sandstone, Mercer Shale, and the Conoquenessing Sandstone.

Deep mining of the Lower Kittanning coal has taken place beneath portions of the reservoir and surrounding area.



SCALE

0 2 4 6 8 10 miles

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA., DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

SANDY RUN, BIG BROWN, SHIRFS RUN EBENSBURG STORAGE, LAKEMONT, BEAR ROCK NO. 1 AND NO. 2 DAMS, (ALLEGHENY RESERVOIR) STORAGE DAM AND ALTOONA LOWER NO. 2 (HOMER GAP RESERVOIR)

GEOLOGY MAP

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY		DRAWING NUMBER 79- 43-A18
	12-31-79	APPROVED BY		

LEGEND:

Pc

Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections; Brush Creek Limestone in lower part of section.

Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some mineable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestones thicken westward; Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations.

Clinton Group

Predominantly Rose Hill Formation - Reddish purple to greenish gray, thin to medium bedded, fossiliferous shale with intertonguing "iron sandstones" and local gray, fossiliferous limestone; above the Rose Hill is brown to white quartzitic sandstone (Keefer) interbedded upward with dark gray shale (Rochester).

Dm

Marine beds

Gray to olive brown shales, graywacke, and sandstones; contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock; Tully Limestone at base.

Pocono Group

Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Cussewago, Corry, and Knapp Formations; includes part of "Oswayo" of M. L. Fuller in Potter and Tioga counties.

Oriskany Formation

White to brown, fine to coarse grained, partly calcareous, locally conglomeratic, fossiliferous sandstone (Ridgeley) at the top; dark gray, cherty limestone with some interbedded shales and sandstones below (Shriver).

Marcellus Formation

Black, fissile, carbonaceous shale with thick, brown sandstone (Turkey Ridge) in parts of central Pennsylvania.

Onondaga Formation

Greenish blue, thin bedded shale and dark blue to black, medium bedded limestone with shale predominant in most places; includes Selinsgrove Limestone and Needmore Shale in central Pennsylvania and Buttermilk Falls Limestone and Esopus Shale in easternmost Pennsylvania; in Lehigh Gap area includes Palmerton Sandstone and Bowmanstown Chert.

Dms

Wills Creek Formation

Greenish gray, thin bedded, fissile shale with local limestone and sandstone zones; contains red shale and siltstone in the lower part.

Bloomsburg Formation

Red, thin and thick bedded shale and siltstone with local units of sandstone and thin impure limestone; some green shale in places.

McKenzie Formation

Greenish gray, thin bedded shale interbedded with gray, thin bedded, fossiliferous limestone; shale predominant at the base; intraformational breccia in the lower part. Absent in Harrisburg quadrangle and to the east.

Keyser Formation

Dark gray, highly fossiliferous, thick bedded, crystalline to nodular limestone; passes into Manlius, Rondout, and Decker Formations in the east.

Tonoloway Formation

Gray, highly laminated, thin bedded, argillaceous limestone; passes into Bossardville and Poxono Island beds in the east.

Dch

Catskill Formation

Chiefly red to brownish shales and sandstones; includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east.

GEOLOGY MAP LEGEND

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

D'APPOLONIA